FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERIES MANAGEMENT ANNUAL REPORT

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SALMON REGION 2015

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2015 SALMON REGION FISHERIES MANAGEMENT ANNUAL REPORT

HIGH MOUNTAIN LAKES:

STOCKING AND SURVEYS - 2015

ABSTRACT

Regional fisheries staff coordinated with Mackay Fish Hatchery and Sawtooth Flying Service to stock 35,934 fish in 74 high mountain lakes in the Salmon Region in 2015. A total of 55 lakes were stocked with 23,113 Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, 14 lakes with 8,333 triploid Rainbow Trout *O. mykiss*, four lakes with 1,390 Arctic Grayling *Thymallus arcticus*, and one lake with 3,098 Golden Trout *O. mykiss aguabonita*. Four additional lakes that were supposed to be stocked with Arctic Grayling in 2015 were not, due to a supply shortage at Mackay Fish Hatchery. Aerial stocking in 72 lakes took place between August 13 and September 10, in 2015, and backpack stocking for Hindman Lake #1 and Alpine Lake (Iron Creek drainage) took place on August 4 and 18, respectively. Flight costs totaled $5,795 for 2015.

In 2015, fisheries staff attempted to survey 60 high mountain lakes that were stocked in 2013 to evaluate growth and relative abundance of stocked fish. Seventy-six total waterbodies were surveyed, including 37 targeted and 39 opportunistic. We found fish present in 38 (50%) of the 76 waterbodies sampled. Westslope Cutthroat Trout were found in 32 lakes, Rainbow Trout were found in five lakes, apparent Cutthroat x Rainbow Trout hybrids were found in five lakes, and Arctic Grayling were found in three lakes. Golden Trout, Eastern Brook Trout *Salvelinus fontinalis*, and tiger muskellenge *Esox masquinongy x Esox Lucius* were each found in one lake.

Amphibians were found in 42 (55%) of the 76 surveyed waterbodies in 2015. Amphibians were found in 40% of lakes that contained fish, and 72% of fishless lakes. We documented amphibian presence in 18 water bodies where they were not previously documented, in 2015.

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INTRODUCTION

Anglers fishing high mountain lakes in Idaho have consistently expressed high satisfaction with their experience (IDFG Fisheries Management Plan 2013-2018). High mountain lakes offer diverse angling opportunities in highly scenic areas and are an important contributor to the state's recreational economy.

Stocking hatchery trout plays a vital role in managing angling opportunities in mountain lakes. Of over 1,000 Salmon Region high mountain lakes, 196 are currently being stocked on a three-year rotation, and five are stocked every year. Idaho Department of Fish and Game (IDFG) primarily stocks four species of trout fry (TL <76 mm) in high mountain lakes: Arctic Grayling *Thymallus arcticus* (GRA), Golden Trout *Oncorhynchus aguabonita* (GN), triploid Rainbow Trout *O. mykiss* (RBT), or Westslope Cutthroat Trout *O. clarkii* (WCT) fry (>75 mm TL). In rare circumstances, IDFG also periodically stocks predator species (i.e. tiger muskellunge *Esox masquinongy x Esox Lucius* [TM] or tiger trout *Salmo trutta x Salvelinus fontinalis* [BB]) in some high mountain lakes to reduce abundance of other fish species (i.e. Eastern Brook Trout *Salvelinus fontinalis* [EBT]). The three-year stocking rotation maintains a diverse size structure of fish and ensures fish populations persist in mountain lakes where natural reproduction is not sufficient. As of fall 2015, stocking rotation A includes 59 lakes, rotation B is comprised of 77 lakes, and rotation C has 60 lakes. The stocking rotation list is adjusted annually to reflect up-to-date survey information and current management goals.

In 2015, we began an intensive three-year evaluation of the effectiveness of our current high mountain lake stocking program. Over the next three years, we plan to survey all stocked high mountain lakes to assess fish growth (length-at-age 2), species composition, and relative abundance (catch per unit effort, CPUE). Study results will be used to inform potential stocking changes (i.e. density, species, or frequency) to improve fishing quality in these high mountain lakes.

OBJECTIVES

Mountain Lake Stocking

1. Provide diverse high mountain lake fisheries throughout the Salmon Region (i.e. diverse species and size structure), with emphasis placed on high-use areas where natural reproduction does not occur.

Mountain Lake Surveys

1. Identify high mountain lakes that currently support naturally reproducing trout populations, and determine whether natural reproduction is adequate for maintaining quality fisheries

2. Assess fish growth and relative abundance in stocked high mountain lakes.

3. Gather current fish community data to manage high lake stocking and provide accurate fish population information to anglers.

STUDY AREA

The Salmon Region contains more than 1,000 high mountain lakes. These range from small ponds that are less than one hectare in size to 70 ha (Sawtooth Lake #1 in the Stanley Basin). Regional high mountain lake elevations range from 1,970 m to over 3,000 m. Further information on each specific lake that was surveyed in 2015 can be found in the results section of this chapter.

METHODS

Mountain Lake Stocking

One-hundred and ninety-six (196) high mountain lakes throughout the Salmon Region are currently stocked on a three-year rotation. The stocking program helps maintain trout in high mountain lakes that could not otherwise support a fishery (i.e. lack of natural reproduction).

High mountain lake stocking densities and species requests are coordinated between regional staff and Mackay Fish Hatchery staff each spring. Fish are hatched and reared at Mackay Fish Hatchery, who coordinates with the contracting aviation company (Sawtooth Flying Service, McCall, ID) to stock the lakes with the correct species and numbers of fish. As of fall 2015, 59 lakes are stocked on rotation A, 77 lakes on rotation B, and 60 lakes on rotation C. Rotation B lakes were stocked in 2015 (Table 1).Each stocking rotation usually requires multiple flights and/or days to complete all stocking for one rotation. Flight routes for each rotation were refined in recent years to keep flight time and fuel costs efficient. Further details of regional aerial stocking methodology were reported in Flinders et al. (2013).

Aerial stocking in 72 lakes took place between August 13 and September 10, in 2015, and backpack stocking for Hindman Lake #1 and Alpine Lake (Iron Creek drainage) took place on August 4 and 18, respectively. Total flight costs for 2015 stocking were $5,795, for an average flight cost of $80.48 per lake.

Mountain Lake Surveys

All lakes on rotation C (those stocked in 2013) were targeted for surveys in 2015, while rotation A lakes will be targeted in 2016, and rotation B lakes in 2017. Salmon Region fisheries staff surveyed 76 high mountain lakes and ponds in the Lemhi, Pahsimeroi, Upper Salmon, Middle Fork Salmon, and Yankee Fork Salmon River drainages in 2015. Thirty-seven of 60 (62%) rotation C lakes were successfully surveyed, and 39 other waterbodies were surveyed opportunistically. We sampled the fish community at each of the 37 target lakes using one mountain lake gill net fished overnight. Fish and amphibian presence was estimated at the other 39 lakes by a combination of angling and visual surveys (n=36) or by gill netting (n=3). Monofilament gill nets were 36 m long by 1.8 m deep, and composed of six panels of 10.0, 12.5, 18.5, 25.0, 33.0, and 38.0 mm mesh. Unfortunately, gill net type (floating or sinking) was not recorded in 2015 due to a miscommunication, but protocol shall ensure those details are recorded for future surveys. Captured fish were measured to the nearest mm total length (TL), weighed in grams (g). Sagittal toliths were collected from three to five fish in each 10 mm size class for age-structure analysis. Otoliths were prepared for sectioning at the Salmon regional office, and sectioned and digitized by the fish ageing lab at IDFG's Nampa Research office (L. Mamer, IDFG, personal communication). Cross-sectioned otoliths were photographed at 40x magnification and read by two independent readers. Discrepancies in age estimates between readers were settled by a third reader.

Survey crews visually and subjectively assessed fish spawning potential and the presence of natural reproduction at each lake, based on estimated total spawning area (m^2) and the presence of redds, fry, and/or fingerlings. Potential natural reproduction was also determined based on findings derived from fish age distribution data using otoliths. Physical characteristics of each lake, weather conditions at the time of survey, access information and the amount of human use were also recorded. Human use was subjectively classified as none, low, moderate, or high based on the abundance of fire rings, user trails, and litter around the lakes. Average and maximum depth was also measured when time allowed, by traversing the lake in a floating packraft and recording depths taken using a handheld depth finder (Hondex PS-7).

At each lake, we assessed presence and relative abundance of amphibians using a modification of the timed visual encounter survey (VES) (Crump and Scott 1994). The main deviation from the VES methodology was that the survey crew performed a full perimeter search without accounting for various habitat types. Survey data was entered into the statewide mountain lake database for future analysis.

RESULTS AND DISCUSSION

Mountain Lake Stocking

Seventy-two lakes were stocked by fixed-wing aircraft in 2015, and two lakes were stocked by backpacking crews. In total, 55 lakes were stocked with 23,113 Westslope Cutthroat Trout (WCT), 14 lakes with 8,333 triploid Rainbow Trout (RBT), four lakes with 1,390 Arctic Grayling (GRA), and one lake with 3,098 Golden Trout (GN) (Table 2). Four lakes that were supposed to be stocked with Arctic Grayling in 2015 were not (Rainbow, Seafoam #6, Upper Redfish #1, and Vanity #13), due to a shortage at Mackay Fish Hatchery.

Mountain Lake Surveys

We surveyed 37 of 60 (62%) rotation C lakes by gill netting in 2015 (Table 3), and 39 other water bodies were surveyed by a combination of angling and visual surveys (n=36), or gill netting (n=3) (Table 4). Of the 23 rotation C lakes not surveyed, 19 are located in the Bighorn Crags basin in the Frank Church Wilderness, and were not accessible due to a trail closure associated with the Middle Fork Complex fire in 2015. We will attempt to survey those lakes in 2016.

Lemhi River Drainage

Basin Creek Lakes Region – There are five lakes in the Basin Creek Lakes basin, and two are currently stocked on rotation C (Basin Creek Lakes #4 and #5). Basin Creek #4 (McNutt Lake) was first stocked in 1974 with RBT, and since 1989 has been stocked every two to three years with ~350 WCT. Basin Creek #5 was first stocked in 1956 with RBT, after which time it was stocked exclusively with WCT with the exception of WCTxRBT hybrid trout in 1980. Basin Creek #5 is currently stocked once every three years with ~1,000 WCT. Human use is moderate at Basin Creek #4 and #5, due to their relatively easy access and close proximity to the town of Salmon (Table 3). Basin Creek Lakes #1, #2, #4, and #5 were surveyed between July 16th and July 17th, 2015.

Basin Creek Lake #1 and #2– No fish were observed during visual surveys at either of these lakes, but Columbia Spotted Frogs (CSF) and Long-toed Salamanders (LTS) were both observed (Table 4). Maximum depth was estimated at 0.5 meters (Table 4).

Basin Creek Lake #4 (McNutt Lake) - One gill net was set in Basin Creek #4 for 12.0 hours and caught 13 WCT and eight WCTxRBT hybrid trout (combined CPUE 1.5 fish/hr,Table 5). Total Length of WCT ranged from 162 mm to 383 mm TL, with an average (± standard error) of 278 mm (± 22.2, *n*=13) (Table 5, Figure 1). Total length of WCTxRBT hybrid trout ranged 150 mm to 351 mm TL, with an average of 202 mm (±24.9, *n*=8) (Table 5 and Figure 1). Three anglers fished the lake for a combined 0.75 hours and two WCTxRBT hybrid trout were caught. No amphibians were observed in 2015 (Table 3). Natural reproduction is likely occurring in this lake, as indicated by the presence of hybrid trout (Figure 1) and all age classes of trout between 3 and 7 (Figure 2). The lake seems to be providing adequate catch rates and a diversity of sizes and species with the current stocking regime. No change is recommended (Table 6).

Basin Creek Lake #5 (Basin Lake) – One gill net was set in Basin Creek #5 for 14.00 hours and caught nine RBT, five WCT, and five WCTxRBT hybrid trout (combined CPUE 1.35 fish/hr) (Table 5). Rainbow Trout ranged from 187 mm to 346 mm TL, with an average 256 mm (±19.0, *n*=9). WCT ranged from 225 mm to 365 mm TL with an average of 286 mm (±30.0, *n*=5). WCTxRBT hybrid trout ranged from 181 mm to 381 mm TL, with an average of 283mm (±43.3, *n* = 5) (Table 5, Figure 1). Long-toed salamander *Ambystoma macrodactylum* (LTS) were observed (Table 3). This lake currently offers a diversity of trout species with relatively high catch rates and diverse size structure. The largest WCT we caught was estimated at 4 years old, but we caught hybrid WCTxRBT as old as 11 (Figure 2). Natural reproduction is likely occurring based on the presence of hybrid trout species, but Westslope Cutthroat Trout stocking should continue to help sustain the fishery. No change is recommended (Table 6).

Bear Valley Lakes – There are three large lakes and four small ponds in the Bear Valley Lakes basin. Only one lake is currently stocked (Bear Valley #3). Bear Valley #3 was first stocked in 1983 with WCT, and is currently stocked on a three-year rotation with ~150 WCT. Bear Valley #1 and #2 were last stocked in 1998 with 1,000 WCT each, but both lakes were removed from the stocking rotation due to adequate natural reproduction for sustaining fisheries. Human use is moderate at the Bear Valley Lakes, due to easy hiking access and close proximity to the town of Salmon (Tables 3 and 4). Bear Valley #1 and #3 were surveyed between July 7th and July 8th, 2015.

Bear Valley Lake #1– One gill net was set in Bear Valley #1 for 16.00 hours and caught 13 RBT, one WCT, and two WCTxRBT hybrid trout (combined CPUE 1.0 fish/hr) (Table 5). RBT ranged in length from 157 mm to 360 mm TL and averaged 239 mm (± 15.1, *n* =13). WCTxRBT hybrid trout measured 159 mm and 180 mm TL (*n* = 2) and the WCT measured 365 mm (Table 5, Figure 1). Numerous redds were observed along the lakeshore in Bear Valley #1 in 2015, with spawning fish on them in some cases, confirming spawning behavior. However, we did not age these fish to confirm, but it is likely that natural reproduction has sustained this trout population since stocking was discontinued in 1998. Despite apparent natural reproduction, WCT are in relatively low abundance, so it is recommended to stock WCT in 2016 (Table 6), and re-evaluate this lake in 2018 to determine if the fishery benefited. This fishery should be managed to provide higher catch rates due to high angler use.

Bear Valley Lake #3– One gill net was set for 16.00 hours and caught 15 WCT (CPUE 0.93 fish/hr) (Table 5). Fish ranged from 173 mm to 308 mm TL and averaged 237 mm (± 7.6, n =15) (Table 5, Figure 1). Surveyors noted there was adequate spawning habitat in the lake in 2015, though no redds were observed. No amphibians were observed in 2015 (Table 3). Westslope Cutthroat Trout in the lake appear to grow slowly despite a relatively low stocking density (130 fish/ha) (Table 5), with older fish showing very little growth (Figure 2). In addition to the presence of stocked fish, natural reproduction is also likely, as we captured fish of all ages between 1 and 5 in our gill net (Figure 2). Since Bear Valley Lake #3 is likely the least visited of the three lakes in the Bear Valley series, we recommend trying to improve fish size by reducing or halting stocking altogether (Table 6). The lake should be surveyed again in 2018 to ensure adequate catch rates are maintained through natural reproduction alone.

Buck Lakes – There are three lakes (#1, #3, and #4) and four small ponds in the Buck Lakes basin. Only #4 is currently stocked. Buck #4 was first stocked in 1996 with WCT, and since 2001 has been stocked with ~225 GRA on a three-year rotation. Buck #1 was last stocked in 1992 with 250 GRA and Buck #3 was last stocked in 2007 with 226 GRA. Human use at the Buck Lakes is moderate, due to easy trailed access and close proximity to the town of Salmon (Table 3). Buck #4 and the four small ponds were surveyed between July 6th and July 7th, 2015.

Buck Lake #4 – One gill net was set for 14.00 hours and captured 28 GRA (CPUE 2.07 fish/hr) (Table 5). GRA ranged in size from 160 mm to 267 mm TL and averaged 233 mm (± 6.0, n = 28) (Table 5, Figure 1). Additionally, two GRA were caught during 0.5 hours of angling effort (CPUE 4.0 fish/hr). No amphibians were observed in 2015 (Table 3). Otolith analysis shows that natural reproduction is present in the lake, and that fish are long-living (up to age 12) and very slow growing (Figure 2). Recommend halting stocking here to try and increase growth for naturally reproducing Grayling in the lake (Table 6). Re-evaluate in 2018 to make sure natural reproduction is adequate for sustaining a quality fishery.

Buck Lakes #1A, #2, #4A, and #4B – These four ponds were visually surveyed for fish and amphibian presence in 2015. Buck #1A was dry, and Bucks #2, #4A, and #4B were very shallow and no fish or amphibians were observed in 2015 (Table 4).

Everson Lake – Everson Lake was first stocked in 1951 with RBT, and was stocked two more times with RBT (1962 and 1965) before being switched to WCT stocking in 1968. The lake is currently stocked with ~1,500 WCT on a three year rotation, and receives a moderate to high level of human use, as it is easily accessible by ATV/Jeep trail (Table 3), near the town of Leadore. The lake was surveyed on August 13th and August 14th, 2015.

Everson Lake – Two gill nets were set for a combined 24.0 hours and captured 37 RBT and nine WCTxRBT hybrid trout (CPUE 1.92 fish/hr) (Table 5). RBT ranged in size from 89 mm to 273 mm TL and averaged 201 mm (± 8.4, n = 37). WCTxRBT hybrid trout ranged 159 mm to 197 mm TL and averaged 183 mm (± 4.9, n = 9) (Table 5, Figure 1). Fingerling trout were present in the lake, along with approximately 200 m^2 of spawning habitat along the shoreline. Natural reproduction is undoubtedly occurring in Everson, as no RBT or WCTxRBT hybrid trout have been stocked in over 30 years. However, WCT stocking over the last 30 years has not been effective at establishing a quality WCT fishery at Everson. Stocked WCT are not surviving and contributing to the fishery, therefore stocking should be discontinued (Table 6). The lake should be re-evaluated in a few years to determine whether natural reproduction alone can sustain high catch rates. The oldest fish we observed were around age 9, and only reached a maximum size of around 273 mm TL (Figure 2). With the lakes high level of use, it should continue to be managed for high catch rates, despite relatively poor growth.

Nez Perce Lake – Nez Perce Lake was first stocked in 1957 with RBT. The lake was also stocked with RBT and GN in 1978, and GRA in 1982. Since 1992, Nez Perce Lake has been stocked exclusively with GRA, and is currently stocked on a three-year rotation with ~250 GRA per event. The Idaho state record for GRA came from Nez Perce Lake in 1992, measuring 460 mm TL and weighing 1,105 g. Human use at Nez Perce is moderate (Table 3), likely due to easy access and "state record" status. We surveyed Nez Perce between July 23rd and July 24th, 2015.

Nez Perce Lake – One gill net was set for 15.0 hours and caught 99 GRA (CPUE 6.60 fish/hr) (Table 5). Fish ranged from 95 mm to 265 mm TL and averaged 181 mm (± 3.4, n = 99) (Table 5, Figure 1). Additionally, 24 GRA were caught during 3.75 hours of angling effort (CPUE 6.40 fish/hr). A combination of regular stocking and natural reproduction in Nez Perce Lake has resulted in an overabundance and subsequently stunted GRA in the lake. Grayling of all age classes from 1 to 6 were observed, with very slow growth between age classes (Figure 2). Age 6 fish only reached a maximum of 265 mm TL. Although catch rates within this lake are extremely high, anglers would like to see larger Grayling caught. With Nez Perce Lake having the 'state-record' status, managing it for trophy size fish will complement Buck Lake #4, which will be managed for relatively higher catch rates of Grayling. We recommend halting stocking and, in addition, introducing a predator (i.e. Tiger Trout) or manually removing some Grayling biomass to improve size structure and growth in the population (Table 6). Re-evaluate in 2018.

Right Fork Big Eightmile Lake – RF Big Eightmile Lake was first stocked in 1975 with WCT, and is currently stocked with 150 WCT on a three-year rotation. Human use is low, as it is a 7 mile hike to reach the lake (Table 3). There is one shallow pond located above RF Big Eightmile Lake, which was visually surveyed in 2015 for amphibians (Table 4). The RF Big Eightmile basin was surveyed between July 16th and July 17th, 2015.

Right Fork Big Eightmile Lake – One gill net was set for 12.00 hours and caught four WCT (CPUE 0.33 fish/hr) (Table 5). Lengths ranged from 102 mm to 286 mm TL and averaged 224 mm (± 48.6, n = 4) (Table 5, Figure 1). Additionally, five WCT were caught during 0.5 hours of angling (CPUE 10.0 fish/hr), ranging from 229 mm to 279 mm TL and averaging 255 mm (± 12.2, n =

5). We did not collect any age structure data from these fish. Fingerlings were observed along the lakeshore, suggesting natural reproduction may be occurring. Since this lake likely receives low use, we recommend halting stocking and resurveying the lake to determine whether natural reproduction is adequate for sustaining the fishery on its own (Table 6). This may also help in improved fish size structure.

Right Fork Big Eightmile Lake #A– This small pond was surveyed visually for amphibians, but none were observed (Table 4).

Upper Main Stem Salmon River Drainage

Middle Fork Hat Creek Lakes – The MF Hat Creek basin contains nine waterbodies, of which four are currently stocked. Currently, MF Hat Creek Lake #2 is stocked with Arctic Grayling, MF Hat Creek lakes #3 and #4 are stocked with Rainbow Trout, and MF Hat Creek Lake #5 is stocked with Westslope Cutthroat Trout. Additionally, MF Hat Creek Lake #1 was historically stocked until 1981, but removed due to reported natural reproduction. MF Hat #2 was first stocked in 1962 with WCT, but has been stocked with GRA since 2001. It is currently set to receive 500 GRA once every three years, but was not stocked (for unknown reason) in 2013. MF Hat #3 and #4 were first stocked in 1957 with WCT and are currently stocked with 1,000 triploid RBT and 300 triploid RBT on the three-year rotation, respectively. MF Hat #5 was first stocked in 1977 with WCT and is now stocked on the three-year rotation with 1,075 WCT. The MF Hat Creek basin lakes were classified as receiving a relatively low to moderate level of human use in 2015 (Tables 3 and 4), but the last time they were surveyed, in 2007, human use was rated as high. The lakes are easily accessible from the Iron Lakes trailhead near Salmon. These lakes were surveyed between June 29th and July 1st, 2015.

Middle Fork Hat Creek Lakes #1 and #1A –One gill net, set during the middle of the day for 6.25 hours, captured eight WCT and one GRA (CPUE 1.44 fish/hr) (Table 5). WCT ranged in lengths ranged from 146 mm to 337 mm TL and averaged 260 mm (± 25.2, n = 8), and the GRA measured 311 mm (Table 5, Figure 3). GRA have never been stocked in MF Hat #1, but were last stocked in MF Hat #2 in 2010 and very well could have colonized MF Hat #1 via stream connectivity. Catch rates and fish size structure are good in this lake, but the large Grayling caught indicates an opportunity to diversify species composition to improve angler experience. Unfortunately, the GRA was not aged, but WCT grow well in the lake and can reach up to age 6 (Figure 4). Consider supplemental stocking of Grayling fry to diversify the fishery (Table 6).

Middle Fork Hat Creek Lake #2 – One gill net was set for 1.25 hours in 2015, but no fish were captured. Two anglers also fished the lake for 1 hour and did not catch any fish. Although surveyors determined the lake was fishless in 2015, due to the missed stocking event in 2013 we recommend stocking in 2016 (Table 6) and re-evaluating fish survival in 2018 before discontinuing stocking. Maximum lake depth was estimated at 4.6 m in 2015 (Table 3), so annual winter kill is certainly possible. We documented numerous CSF and LTS present along the lake perimeter in 2015 (Table 3).

Middle Fork Hat Creek Lake #3 – We captured one RBT during 0.75 hours of angling (CPUE 2.66 fish/hr) and eight RBT during 12.17 hours of gill netting (CPUE 0.66 fish/hr) in 2015 (Table 5). Gill netted fish ranged in length from 168 mm to 241 mm TL, and averaged 203 mm (± 10.0, n = 8) (Table 5, Figure 3), and one of the angled fish measured 419 mm TL and weighed over 600 grams. The fish was estimated at age 5, which suggests excellent growth relative to most of the lakes we surveyed this year (Figure 4). Survey crews noted observations of fingerlings at the lake in 2015, but spawning suitability was rated as poor so natural reproduction, if present, is probably very low. We recommend continuing current stocking levels to maintain this lake as a relatively high catch rate fishery with the possibility to catch some large fish as well (Table 6).

Middle Fork Hat Creek Lake #4 – In an 8.50 hour daytime gill net set we captured one RBT from MF Hat #4 (CPUE 0.12 fish/hr, Table 5). The fish measured 508 mm and weighed 600 grams (Table 5, Figure 3). The last time this lake was surveyed, in 2001, three RBT and one WCT were caught, and no fish measured greater than 299 mm (CPUE unknown). We recommend continuing with the current stocking (Table 6). Despite very low catch rates, this lake provides a chance to catch relatively larger fish than are available in the neighboring lakes.

Middle Fork Hat Creek Lakes #4A, #4B and #4C – These lakes are very shallow (Table 4), and were surveyed only for amphibians in 2015. Columbia Spotted Frog and LTS were observed at MF Hat #4A and #4B in 2015, but no amphibians were found at #4C (Table 4).

Middle Fork Hat Creek Lake #5 – One gill net was set in MF Hat #5 for 17.33 hours, which captured 14 WCT (CPUE 0.81 fish/hr) (Table 5). Total length ranged from 108 mm to 324 mm TL and averaged 224 mm (± 19.5, n = 14) (Table 5, Figure 3). The survey crew noted that spawning potential was high in the littoral zone of the lake, and even noted redd observations, but previous surveyors classified the lake as having no natural reproduction potential. Otolith analysis confirmed that natural reproduction may be present, but we may have also mis-aged 2 year old fish as age 3. Fish stocked in 2010 returned to sampling gear well, but no age-2 fish were encountered in our sample (Figure 4). We recommend halting stocking (Table 6) for one rotation (2016) and evaluate whether natural reproduction can maintain adequate catch rates and perhaps improve size structure. Re-evaluate in 2018.

Reynolds Creek Lakes – There are five lakes in the NFEF Reynolds Lake basin, two of which are currently stocked on rotation C. NFEF Reynolds #2 was first stocked in 1958 with RBT and is now stocked on a three year rotation with ~1,300 WCT. NFEF Reynolds #4 was first stocked in 1937 with RBT and is currently stocked on a three-year rotation with ~1,000 WCT. Both lakes receive a moderate level of human use, as NFEF Reynolds #4 can be reached by a relatively short hike on trail (~1.5 miles) (Table 3). These lakes were surveyed between July 23rd and July 24th, 2015.

North Fork East Fork Reynolds Lakes #2 and #4 – We caught four WCT during three hours of angling at NFEF Reynolds #2 (CPUE 1.30 fish/hr) and 12 WCT during three hours of angling at NFEF Reynolds #4 (CPUE 4.00 fish/hr) (Table 5). Gill netting surveys caught two WCT in 14.50 hours (CPUE 0.14

fish/hr) at NFEF Reynolds #2, and 10 WCT in 15.33 hours (CPUE 0.65 fish/hr) at NFEF Reynolds #4 (Table 5). Total length of gill netted fish at NFEF Reynolds #2 ranged from 292 mm to 406 mm and averaged 349 mm (± 80.6, *n* = 2) (Table 5, Figure 3). Total length of gill netted fish at NFEF Reynolds #4 ranged from 210 mm to 337 mm TL and averaged 275 mm (± 15.5, *n* = 10) (Table 5, Figure 3). The 406 mm TL WCT caught in NFEF Reynolds #2 was estimated at age 5, so this does not confirm natural reproduction. With NFEF Reynolds #2 having relatively lower catch rates but excellent growth and NFEF Reynolds #4 having a relatively higher angling catch rate and slightly slower growth (Figure 4), no change is recommended (Table 6). All fish captured were between 3 and 6 years old. Fishing options in these lakes complement each other well and each present a diversity of sizes.

North Fork East Fork Reynolds Lake #4A – According to IDFG stocking records, NFEF Reynolds #4A has never been stocked. However, in 2014 a visual survey of the waterbody documented small WCT present, and suggested probable fish movement between NFEF Reynolds Lakes #4 and #4A. In 2015, we saw 10-15 adult WCT in NFEF Reynolds #4A. Again, these fish probably colonized NFEF Reynolds #4A from #4, as it is situated on the outlet of #4, approximately 50 m downstream. CSF were observed along the lake shore of NFEF Reynolds #4A for the first time in 2015 (Table 4).

South Fork Moyer Creek Lake – SF Moyer Creek Lake was first stocked in 1969 with GRA and is currently stocked with ~225 GRA on a three-year rotation. The lake was also stocked with WCTxRBT hybrid trout in 1980. In 2015, we classified a low level of human use (Table 3). The lake was surveyed between June 30th and July 1st, 2015.

South Fork Moyer Creek Lake – We fished the lake for one hour in 2015 and caught one WCT (CPUE 1.0 fish/hr) (Table 5). Additionally, 18.75 hours of gill netting resulted in capturing nine WCT, three RBT, and one WCTxRBT hybrid (CPUE 0.69 fish/hr). Gill netted WCT ranged in size from 89 mm to 406 mm TL and averaged 248 mm (± 50.9, *n* = 9), RBT ranged in size from 292 mm to 343 mm TL and averaged 320 mm (± 18.2, *n* = 3), and the hybrid trout we captured in our gill net measured 318 mm and weighed 300 grams (Table 5, Figure 3). No GRA were angled, netted or observed in 2015, even though they were the only species stocked from 1989 to present. Given that 3 of the 13 fish netted were less than 100 mm, and nothing but GRA have been stocked in the lake since 1980, we believe natural reproduction is solely supporting the fishery. WCT were present from ages 1 to 6, and reached over 400 mm TL by age 6 suggesting excellent growth potential (Figure 4). We recommend discontinuing the stocking of Grayling (Table 6) and re-evaluating catch rates in 2018 to ensure natural reproduction in sufficient for maintaining a quality fishery.

Spruce Gulch Lake –Spruce Gulch Lake has had seven stocking events since 1937, when Eastern Brook Trout (EBT) were first introduced. WCT were also stocked in Spruce Gulch Lake (1948, 1959, and 1964) but never became established. As of 2005, naturally reproducing EBT were the only fish species in the lake. In 2007, 439 Tiger Muskellunge *Esox masquinongy x Esox Lucius* (~317 mm TL) were stocked to evaluate their effectiveness as a tool to eliminate/reduce EBT abundance (Esselman et al. 2007 and Koenig el al. 2015). No fish have been stocked in the lake since then. The last time we surveyed Spruce Gulch Lake was in 2013, where we captured five EBT via angling

(CPUE 0.8 fish/hr), ranging 170 mm to 235 mm TL, and averaging 205 mm, and two 760 to 890 mm Tiger Muskie were visually observed cruising the shoreline. Human use at Spruce Gulch Lake is likely lower than it had been when EBT abundance was higher. The lake is easily accessible by ATV and would likely receive high angling pressure if the quality of the fishery was improved. Two lowland lake experimental gill nets (one sink, one float) were set on July 14th and retrieved July 15th, 2015.

Spruce Gulch Lake – During 30.0 hours of combined effort with one sinking and one floating gill net, seven EBT were caught (CPUE 0.23 fish/hr) (Table 5). EBT lengths ranged from 152 mm to 311 mm TL and averaged 231 mm (± 28.8, n=7) in 2015 (Table 5 and Figure 2). Additionally, one large Tiger Muskie was observed from shore (~650 mm TL) (Table 5). No amphibians were observed in 2015 (Table 3). Abundance of EBT has been greatly reduced since Tiger Muskellunge were introduced, and it is time to consider once again trying to establish a Westslope Cutthroat Trout fishery (Table 6). However, manual removal of the remaining Tiger Muskie in the lake may be necessary before stocking takes place.

U P Lake – U P Lake was first stocked with WCT in 1952, and is currently stocked with ~1,000 WCT on a three-year rotation. Human use at U P Lake is relatively high compared to other mountain lakes in the Salmon region, as the lake is easily accessible by a Jeep/ATV trail leaving directly from the town of Salmon (Table 3). The lake was surveyed on August 4th and 5th, 2015.

U P Lake – One gill net was set for 12.67 hours in 2015, and captured four WCT (CPUE 0.32 fish/hr) (Table 5). Fish ranged in length from 299 mm to 413 mm TL and averaged 377 mm (± 31.1, *n*=4) (Table 5, Figure 3). Additionally, a WCT carcass was found along the shoreline of the lake, which measured 553 mm. CSF were observed in low abundance at the lake in 2015 (Table 3). Anglers have come to expect catching larger than average size trout in this lake. We believe we can continue to meet this expectation while improving catch rates by increasing WCT stocking. Otolith analysis suggested natural reproduction does not occur at all at U P Lake, as the fish we caught were either age 2 or age 5 (stocked in 2013 or 2010) (Figure 4). Considering fish age, they grow extremely well in U P Lake. We recommend a slight increase in stocking density in 2016, and re-evaluating in 2018 to determine how increased stocking density affects fish growth (Table 6). If we find that growth is negatively impacted by the stocking density change, we will likely revert the change.

Middle Fork Salmon River Drainage

Knapp Lakes – There are upwards of 25 lakes, ponds, and vernal pools located in the Knapp Lakes basin. Only two lakes within this basin are currently stocked: Knapp #7 and Knapp #14. Knapp #7 has been stocked since 1988 on a three year rotation with 200-500 Westslope Cutthroat, and Knapp #14 has been stocked with 75-250 Arctic Grayling (GRA) on a three year rotation since 2001. Knapp #7 and #14 (stocked on rotation C) were gill netted on July 12th, 2015. Human use appears to be low for the Knapp Lakes due to their remoteness (minimum 7 mile hike) (Table 3). Seventeen additional water bodies within the Knapp Lakes basin (Table 4) were surveyed for amphibian presence and abundance between July 12th and July 13th, 2015.

Knapp Lakes #7 and #14 –In Knapp #7, 15 WCT were captured in 15.37 hours of gill netting (CPUE 0.98 fish/hr) (Table 5). Fish lengths ranged from 168 mm to 304 mm TL and averaged 256 mm (± 10.7, *n* = 15) (Table 5, Figure 5). In Knapp Lake #14, 24 GRA were netted in 15.22 hours (CPUE 1.58 fish/hr). Grayling ranged 228 mm to 424 mm TL and averaged 300 mm (± 8.2, *n* = 24) (Table 5 and Figure 5). Although these lakes were classified as having very little to no suitable spawning habitat to support naturally reproducing fish, otolith information suggests natural reproduction does occur (Figure 6). However WCT stocking provides relatively high catch rates in Knapp #7, and GRA growth in Knapp #14 is excellent under the current stocking program (Figure 6), thus stocking should continue (Table 6).

Knapp Lakes #3, #4, #5, #5C, #6, #7A, #8, #9, #10, #11, #11A, #12, #13, #14A, #15, #16, and #17 – These 17 water bodies within the Knapp Lakes basin are small, fishless lakes and ponds (Table 4). We surveyed each lake for amphibian presence and abundance between July 12th and 13th, 2015. We documented amphibian presence in 14 of the 17 waterbodies; CSF in all 14 and Western Long-Toed Salamanders (LTS) in Knapp Lake #8 (Table 4). This was the first year amphibians were documented at Knapp Lakes #8, #11A, #13, and #17.

Lola Lakes – There are three lakes and one ephemeral pool within the Lola Lake basin. Lola Lakes #2 and #3 are the only stocked water bodies in the basin, both of which have been stocked with ~500 Westslope Cutthroat on a three year rotation since 1988. Although human use was classified as low in 2015, it is a relatively easy four mile hike from the trailhead to the Lola basin (Table 3). Lola Lakes #2 and #3 were angled and gill netted between August 7th and August 8th, 2015.

Lola Lakes #2 and #3 – Five WCT were caught during two hours of angling (CPUE 2.5 fish/hr) in Lola #2, and six WCT were caught during one hour of angling (CPUE 6.0 fish/hr) at Lola #3 (Table 5). Additionally, three WCT were captured from each lake during 18.42 hours (CPUE 0.16 fish/hr) and 14.33 hours (CPUE 0.21 fish/hr) of gill netting, respectively (Table 5). WCT gill netted in Lola #2 ranged from 306 mm to 338 mm TL and averaged 326 mm (± 12.5, *n*=3). In Lola #3, gill netted WCT ranged in size from 285 mm to 343 mm TL, and averaged 308 mm (± 21.9, *n* = 3) (Table 5, Figure 5). No spawning habitat was observed in either lake in 2015, and no fingerlings or fry were observed. However otolith information suggests a small amount of natural reproduction may be present (Table 5). Relatively good growth rates are present in both lakes (Figure 6), so no stocking changes are recommended (Table 6).

Loon Creek Lakes – There are 15 lakes and ponds in the Loon Creek Lakes basin. Five of these were surveyed in 2015. Four are in stocking rotation C, and are the only lakes currently stocked in the basin. Loon #3 (Fish Lake), Loon #11, and Loon #15 were first stocked in the 1960s with ~500 WCT each, and were intermittently stocked with ~500 WCT every three to six years until put on a three-year rotation in 2000. Loon #13 was first stocked in 1966 with WCT and was stocked on a three-year rotation until 1988 with over 1,000 WCT planted during each stocking event. In 1997, Loon #13 was placed back on the stocking rotation, and in 2000, stocking abundances were decreased 25-30% at all four stocked lakes. Loon #14 (not mentioned above and not currently stocked) was initially stocked with WCT in 1988 but was removed from the stocking program in

1997 due to inadequate lake depth (Table 4) for overwintering fish. We visited this lake to confirm whether it was, in fact, fishless in 2015. Human use is low at the Loon Creek Lakes, due to their remoteness (at least 12 miles from the closest trailhead) (Tables 3 and 4). These five lakes in the Loon Creek basin were surveyed between August 4th and August 6th, in 2015.

Loon Creek Lake #3 – We captured 21 WCT in two hours of angling at Loon #3 (Fish Lake) (CPUE 10.5 fish/hr), and 11 WCT in 15.25 gill net hours (CPUE 0.72 fish/hr) (Table 5). Gill netted fish ranged in length from 122 mm to 350 mm TL, and averaged 280 mm (± 20.9, n = 11) (Table 5, Figure 5). We also documented one LTS at the lake in 2015 (Table 3); the first time amphibians have been observed during surveys there. Although natural reproduction appears to be occurring, no stocking changes are recommended for Loon Creek Lake #3 (Table 6), as catch rates are relatively high and fish growth is above average (up to 350 mm TL by age 4 in some cases) (Figure 6).

Loon Creek Lake #11 – We captured 3 WCT in 14.50 hours of gill netting (CPUE 0.20 fish/hr) in 2015 (Table 5). Fish lengths ranged from 382 mm to 466 mm TL, and averaged 412 mm (± 33.3, n = 3) (Table 5, Figure 5). No evidence of amphibian presence or natural reproduction potential for fish was observed at Loon #11 in 2015 (Table 3). We did not age these fish to confirm age distribution, however. In 2000, survey crews noted that Loon #11 was “full” with maximum depth greater than 6 meters; however in 2015, maximum depth was only 2.6 meters (at least 1 meter below high water mark) (Table 3). We recommend increasing WCT stocking in Loon Creek Lake #11 to improve catch rates (Table 6), but re-evaluate in 2018 to monitor length distributions.

Loon Creek Lake #13–Twelve WCT were captured during 15.83 gill net hours in Loon #13 (CPUE 0.76 fish/hr) in 2015 (Table 5). Fish lengths ranged from 206 mm to 396 mm TL and averaged 274 (± 20.9, n = 12) (Table 5, Figure 5). Otolith data and size structure, and the observation of fry in 2015 indicates adequate natural reproduction, with the presence of all age classes from 2 to 4. Age 4 fish reached as large as 396 mm TL (Figure 6). Recommend no change in stocking (Table 6).

Loon Creek Lake #15– Forty-two WCT were netted from Loon #15 in 14.33 hours (CPUE 2.93 fish/hr) (Table 5). Fish lengths ranged 87 mm to 329 mm TL and averaged 177 mm (± 11.9, n = 42) (Table 5, Figure 5). Loon #15 was also angled and 10 WCT were caught in 0.5 hours (CPUE 20.00 fish/hr) (Table 5). Trout fry were also observed in Loon #15 in 2015, suggesting the presence of natural reproduction, although minimal spawning habitat was observed. Extremely high catch rates in Loon Creek #15 suggest a halt in stocking could improve fish size while maintaining adequate catch rates through natural reproduction alone (Table 6). Ageing data showed that fish can reach the maximum observed size by around age 5 or 6, and very little growth is attained between age 5 and the maximum age observed (age 9) (Figure 6). This lake doesn’t see a high amount of angling, so we will continue to manage for relatively low catch rates and larger fish size, if possible.

Loon Creek Lake #14 - Loon #14 was visually surveyed for amphibians in 2015 and six CSF were observed (Table 4). This is the first time we have documented amphibians at the lake. As observed in 1979, Loon #14 is too shallow to support overwintering fish (Table 4) and should remain off the stocking rotation.

Ruffneck Peak/Langer Peak – There are ten lakes between the Ruffneck and Langer Peak basins. Five of those lakes are currently stocked; two on rotation C and three on rotation B. Both rotation C lakes (Rocky and Finger #3) have received 450-475 Westslope Cutthroat Trout (WCT) fry on a three year rotation since 1997. These two lakes were surveyed on August 17th and 18th, 2015. Both lakes were classified as having low human use in 2015 (Table 3).

Rocky Lake and Finger Lake #3 - In 2015, three WCT were gill netted in 13.0 hours at Rocky (CPUE 0.23 fish/hr) (Table 5) ranging from 349 mm to 432 mm TL, and averaging 395 mm (± 30.0, n = 3) (Table 5, Figure 5). One hour of angling at Rocky yielded no fish. These fish were not aged, so we are unsure if natural reproduction is present. Two WCT were angled in three hours of effort (CPUE 0.33 fish/hr) in Finger #3, and 10 WCT were captured during 15.50 hours of gill netting (CPUE 0.65 fish/hr) (Table 5). Gill netted fish ranged in length from 165 mm to 445 mm TL, and averaged 306 mm (± 26.2, n = 10) (Table 5, Figure 5). We did not document amphibians at either of these lakes (Table 3). Minimal spawning potential was recorded for both lakes in 2015 (Table 5). Both lakes contained relatively large fish in 2015, with relatively moderate catch rates. Finger Lake #3 showed some of the best growth of all lakes surveyed in 2015, with fish reaching 450 mm TL by age 3 (Figure 6). Fish older than age 3 were not encountered in Finger #3. No stocking change is recommended in either lake (Table 6). These lakes should continue being managed for large fish size.

Tango Lakes – There are seven lakes in the Tango Creek basin. Three have been stocked regularly with WCT since 1966 and have been on a three-year rotation since 1997. Tango #4 receives 660-750 WCT, Tango #5 receives 250-750 WCT, and Tango #6 receives 750-900 WCT during each stocking event. Human use is likely very low at the Tango Lakes, as there is no trail and cross-country distance for access is at least 5 miles from Bonanza Guard Station (Table 3). There is one large campsite at Tango #5. These lakes were surveyed between July 22 and 23, in 2015.

Tango Lake #4 – Two gill nets were set in Tango #4 for a combined time of 30.1 hours. We caught 16 WCT during gill netting (CPUE 0.53 fish/hr), and five WCT during five hours of angling (CPUE 1.0) (Table 5). Gill netted fish ranged in length from 104 mm to 355 mm TL and averaged 242 mm (± 18.5, n = 16) (Table 5, Figure 5). No amphibians were documented at Tango Lake #4 in 2015 (Table 3). The age distribution suggests some natural reproduction is present, but the lake currently supports a wide range in age classes (2 to 7) (Figure 6) and sizes with relatively moderate catch rates. Recommend no change in stocking density (Table 6).

Tango Lakes #5 – In Tango #5, we captured 23 WCT 0.5 hours of angling (CPUE 44.2 fish/hr) and 22 WCT during 15.00 hours of gill netting (CPUE 1.47 fish/hr) in 2015 (Table 5). Gill netted fish ranged in length from 95 mm to 244 mm TL and averaged 180 mm (± 11.1, n = 22) (Table 5, Figure 5). The age distribution data suggests natural reproduction is occurring, as we saw fish present in every age class from 1 to 5 (Figure 6). The fish in Tango #5 are highly abundant and growing very slowly (Figure 6), possibly as a result of excessive recruitment from natural reproduction in addition to stocking. We recommend eliminating stocking (Table 6) and reassess in 2018 to ensure adequate catch rates are maintained through natural reproduction, and see if fish size can be improved.

Tango Lake #6 – In Tango #6, we captured eight WCT in 16.50 gill net hours (CPUE 0.49 fish/hr) (Table 5). Fish lengths ranged from 84 mm to 410 mm TL and averaged 313 mm (± 36.7, *n* = 8) (Table 5, Figure 5). No fish were caught during 0.25 hours of angling at Tango #6 in 2015. The presence of fingerlings leads to the conclusion that natural reproduction is present, but catch rates are still very low. Age structure of fish in the lake suggests very little angling pressure, as fish were observed up to age 12 (Figure 6). Although catch rates are relatively low, fish size is the largest of the lakes we surveyed in the Tango basin, so this lake offers up the opportunity for anglers in the basin to catch trophy sized fish. No change in stocking is recommended (Table 6).

Pahsimeroi River Drainage

Pass Lake –Pass Lake was first stocked with Cutthroat Trout (unidentified strain) between 1954 and 1977, after which the lake was not stocked again until 2006. In 2006 we began stocking 350 to 700 GN every two to three years. Human use was rated as low in 2015, although the lake is reachable by a 6 mile hike on trail (Table 3). The lake was surveyed between August 26th and August 27th, 2015.

Pass Lake – One gill net was set for 15.00 hours and caught two GN (CPUE 0.13 fish/hr) (Table 5). The two GN measured 342 mm TL and 243 mm TL, and weighed 345 grams and 149 grams, respectively (Table 5, Figure 7). Surveyors also fished the lake for 3.5 hours but did not catch any fish. Numerous fish were observed rising and adequate spawning habitat was documented along the entire eastern shoreline. Although no fingerlings or fry were observed, WCT presence suggests natural reproduction is occurring at a low level in Pass Lake. The two GN we caught were estimated at age 2 (stocked in 2013) and age 5 (Figure 8). Recommend continuing the stocking of Golden Trout (increase if available), and additionally stocking Westslope Cutthroat Trout to improve catch rates (Table 6).

Patterson Creek Lakes – There were name changes in the Patterson Lakes basin in 2015. A lake at the lower end of the basin was added in 2015 and given the name Patterson #1, and the old Patterson #1 was renamed Patterson #3 to follow our standard naming convention where assigned numbers increase as we move up the drainage. The lake now named Patterson #1 has never been stocked or surveyed by IDFG, and was not surveyed in 2015. We recommend stocking the new Patterson #1 and evaluating in 2018 (Table 6).

There are five water bodies in the Patterson Creek Lakes basin. Two lakes are currently stocked on rotation C. Patterson #2 was first stocked in 1983 with WCT and is currently stocked with ~200 WCT once every three years, and Patterson #3 was first stocked in 1983 with WCT and is now stocked once every three years with ~125 WCT. Patterson #2 and #3 were surveyed between August 31st and September 1st, 2015. Human use is low (Table 3).

Patterson Lake #2– One gill net was set in Patterson #2 for 17.67 hours and captured 13 WCT (CPUE 0.74 fish/hr) (Table 5). WCT ranged from 191 mm to 282 mm TL and averaged 247 mm (± 8.6, *n* = 13) (Table 5, Figure 7) . Additionally, one angler fished for 0.67 hours and caught 16 WCT (CPUE 23.88). Fingerlings were observed along shoreline at Patterson #2 and surveyors noted that natural reproduction was likely occurring (Table 5). Ageing data confirms natural reproduction is present, and slow growth is likely as a result of the relatively high abundance of fish in the lake (Figure 8). On average, the difference in length between age 2 and age 6 fish was only ~80 mm (Figure 8). This lake should be removed from the stocking rotation and re-evaluated to see if natural reproduction can sufficiently maintain the fishery, and if fish growth/size can be improved (Table 6).

Patterson Lake #3 – One gill net was set in Patterson #3 for 14.08 hours, but no fish were caught. Maximum lake depth was estimated to be 2.7 meters (Table 3), so overwinter survival for trout may not be possible in some years, depending on the duration of ice-cover and snowpack. No amphibians were observed in 2015 (Table 3). Continue stocking (Table 6) and re-evaluate in 2018. Remove from stocking if fish are not observed in 2018.

Yellow Peak Lake –Yellow Peak Lake (also recognized as Park Fork Creek Lake) was first stocked in 2001 with WCT and is currently stocked every three to four years with ~300 WCT. Human use at the lake is likely very low, although the lake is located very close to a popular motorbike trail near the town of Leadore (Table 3). Yellow Peak Lake was surveyed August 24th and August 25th, 2015.

Yellow Peak Lake – One gill net was set for 15.00 hours and caught 17 WCT (CPUE 1.13 fish/hr) (Table 5). WCT ranged in size from 108 mm to 241 mm TL and averaged 189 mm (± 10.4, *n* = 17) (Table 5, Figure 7). WCT fry and fingerlings were observed near and in the lake outlet in 2015, and otolith analysis also confirmed that natural reproduction is occurring (Figure 8). We saw fish present in almost every age class from 1 to 12, with almost no difference in fish size between age 2 and age 10+ (Figure 8). We believe this lake receives such low use that stocking is not justified in addition to apparent natural reproduction (Table 6). Natural reproduction is likely sufficient for maintaining a high catch rate fishery, and may help improve fish size/growth.

Yankee Fork Salmon River Drainage

Cabin Creek Lakes – There are twelve lakes within the Cabin Creek basin. Three of these lakes are currently stocked on rotation C: Cabin Creek #3, Cabin Creek #4 (Crimson Lake), and Cabin Creek #7. Cabin Creek #3 was first stocked in 2000 with WCT and is currently stocked on a three-year rotation with ~600 WCT. Cabin Creek #4 (Crimson Lake) was first stocked in 1966 with WCT and is currently stocked on the three-year rotation with ~600 WCT (only 100 WCT were stocked in 2013). Golden Trout (GN) were also stocked in Cabin Creek #4 in 1978. Cabin Creek #7 was also first stocked in 1966, with 500 WCT. It is currently stocked on a three-year rotation with ~205 WCT. These lakes and two of the small ponds were surveyed between July 10th and 12th, 2015. Human use was classified as low (Table 3).

Cabin Creek Lake #3 – One gill net was set in Cabin Creek #3 for 16.12 hours and captured 16 WCT (CPUE 0.99 fish/hr) (Table 5). Lengths ranged from 157 mm to 309 mm TL and averaged 239 mm (± 11.0, *n* = 16) (Table 5, Figure 9). Cabin Creek #3 otolith data showed a small amount of natural reproduction (Figure 10). The age structure is also very interesting, consisting of 1-3 year olds and 10+ year old fish. However, fish are very slow growing between age 3 and age 10+ (Figure 10). With relatively high catch rates and slow growth, we recommend reducing the stocking density to try and improve age and size structure (Table 6).

Cabin Creek Lake #4 (Crimson Lake) - One gill net was also set in Cabin Creek #4 (Crimson Lake) for 14.93 hours, which captured 13 WCT (CPUE 0.87 fish/hr) (Table 5). Fish lengths ranged from 145 mm to 357 mm TL and averaged 225 mm (± 18.8, *n* = 13) (Table 5, Figure 9). Age distribution data suggests natural reproduction is present (Figure 10), but the lake currently provides high catch rates and a diverse size structure, so no change in stocking density is recommended (Table 6). Fish in the lake also show fair and consistent growth (~170 mm TL between age 1 and 4) (Figure 10) but this is likely the most visited lake in the Cabin Creek Lakes series, so fish are not as long-lived as in CCL #3. This lake should continue being managed for relatively high catch rates.

Cabin Creek Lake #7 - One gill net set for 16.88 hours in Cabin Creek #7 captured 11 WCT (CPUE 0.65 fish/hr) (Table 5). Lengths in Cabin Creek #7 ranged from 168 mm to 210 mm TL and averaged 189 mm (± 4.7, *n* = 11) (Table 5, Figure 9). Otolith data suggests a majority of the sampled fish were stocked in 2013, and fish older than age 4 are not present (Figure 10). It is possible that this lake could potentially winterkill in some years, with a maximum depth of only 4.3 m (Table 3). Alternately, fish are being harvested before they reach older ages. We recommend increasing stocking density in 2016 (Table 6) and re-evaluating in 2018 to determine if increasing stocking could help improve longevity and recruit older age classes.

Cabin Creek Lakes #2 and #7A –Cabin Creek #2 and # 7A were visually surveyed for amphibian presence and abundance in 2015 (Table 4). For the first time in our records, CSF were documented at Cabin Creek #2 and LTS were documented at Cabin Creek #7A (Table 4).

Cabin Creek Peak Lakes – There are four larger lakes and two small ponds in the Cabin Creek Peak Lakes basin. Only one lake in the basin is currently stocked by IDFG: Cabin Creek Peak #1 (rotation C). Cabin Cr Peak #1 was first stocked in 1991 with 250 WCT and is currently stocked on a three-year rotation with ~150 WCT for each event. Cabin Creek Peak Lakes #3, #4, and #5 have also been stocked at some point, but stocking was discontinued in all three when surveys determined they were too shallow to support overwintering fish. Cabin Creek Peak #3 was stocked with WCT from 1975 thru 2000, Cabin Creek Peak #4 was stocked with WCT from 1969 through 2009, and Cabin Creek Peak #5 was stocked with WCT from 1969 through 1997. Human use is very low in the basin, due to its remoteness (Table 3). In 2015, we surveyed these lakes between July 9th and July 12th, 2015.

Cabin Creek Peak Lake #1 – One gill net was set for 18.48 hours and caught one WCT (CPUE 0.05 fish/hr) (Table 5). The fish measured 276 mm TL (Table 5, Figure 9) and weighed 140 grams. No spawning habitat, fry or fingerlings, or amphibians were documented at this lake in 2015, and we do not believe natural reproduction is occurring (Table 5). The fish we caught was age 5 (stocked in 2010) (Figure 10). We recommend increasing stocking in 2016 to increase fish abundance and catch rates (Table 6).

Cabin Creek Peak Lakes #2 and #3 – These lakes were visually surveyed for fish and amphibian presence/absence in 2015 (Table 4). No fish or amphibians were documented at either water body. Cabin Creek Peak #3 was estimated to be less than 1.0 meters in depth (Table 4).

Hindman Lakes Region – There are three lakes in the Hindman Lakes basin. Stocking began in 1981 for Hindman #1, with WCT, and it is currently stocked every year with ~500 WCT because of its drive-to access and moderate human use (Table 3). Hindman #2 was stocked with WCT from 1982 through 1997 and Hindman #3 was stocked with WCT in 1982, 1985, and 1995. Both have since been removed from the stocking rotation. These lakes were surveyed between July 9th and July 10th, 2015.

Hindman Lake #1 – One gill net was set in Hindman #1 for 15.93 hours and caught 36 WCT (CPUE 2.26 fish/hr) (Table 5). Lengths ranged from 156 mm to 353 mm TL and averaged 261 mm (± 7.1, n = 36) (Table 5, Figure 9). Surveyors determined there was limited natural reproduction potential for fish in the lake in 2015 (Table 5). Age distribution analysis revealed a small amount of potential natural reproduction, with all age classes present from 2 to 7 (Figure 10). With relatively great catch rates and variable size structure, no change in stocking is needed (Table 6). This lake can be driven to, and is near a fairly popular trailhead, so it is managed for high catch rates regardless of fish size.

Hindman Lakes #2 and #3 – These lakes were surveyed visually to determine if fish and/or amphibians were present in 2015. Twenty adult CSF were observed along the shoreline of Hindman #2 and twenty-eight adult and juvenile CSF were observed in Hindman #3 (Table 4). Both lakes contain abundant amphibian habitat and are likely too shallow to support overwintering trout (Table 4).

RECOMMENDATIONS

1. Maintain project goals of sampling a stocking panel each year.
2. Standardize gill net type use and angling during surveys for better comparison of relative abundance.
3. Review and implement annual changes in stocking recommendations for each lake.
4. Use information gathered in these surveys to construct a high mountain lake angling guide for public use.

Table 1. Salmon Region high mountain lake stocking rotations A, B, and C by year, 2014 through 2022.

	Stocking Rotation Sequence		
	A	B	C
Year	2023	2015	2016
of	2017	2018	2019
Stocking	2020	2021	2022

Table 2. High Mountain Lakes stocked in the Salmon Region in 2015 (Rotation B).

Lake	LLID	Catalog #	Species	# of fish
Alpine Creek Lake #11	1149701439146	07-1797	TT	430
Alpine Creek Lake #12	1149699439196	07-1798	C2	510
Alpine Creek Lake #13	1149734439270	07-1800	GR	494
Alpine Creek Lake #14	1149599439213	07-1802	GR	161
Alpine Creek Lake #15	1149715439307	07-1804	GR	368
Alpine Creek Lake #2	1145821435312	07-1784	C2	371
Alpine Creek Lake #4	1149726439072	07-1787	GR	367
Alpine Creek Lake #5	1149815439052	07-1788	TT	127
Alpine Creek Lake #6	1149828439107	07-1789	TT	301
Alpine Creek Lake #7	1149925439093	07-1790	C2	341
Alpine Lake	1150532441816	07-1540	GN	3,098
Baldwin Creek Lake	1151123444950	07-1007	C2	353
Bear Creek Lake #1	1150941444859	07-1137	C2	212
Cliff Creek Lake #1	1150329444797	07-1144	C2	141
Cliff Creek Lake #4	1150234442854	07-1146	C2	71
Collie Creek Lake #1	1152261444092	07-1111	C2	1,081
Decker Creek Lake #1	1149344440479	07-1659	C2	588
Elizabeth Lake	1151514442658	07-1570	C2	494
Elk Lake	1151568441991	07-1163	C2	682
Fishhook Creek Lake #2	1145853440651	07-1607	C2	71
Fishhook Creek Lake #3	1149877441107	07-1610	C2	71
Goat Lake #1	1150196441721	07-1530	C2	2,209
Goat Lake #4	1150154441600	07-1535	C2	423
Goat Lake #5	1150183441535	07-1536	C2	47
Hanson Lake #1	1151172442217	07-1555	C2	235
Hanson Lake #3	1151171442093	07-1558	C2	729
Hanson Lake #5	1151174441998	07-1561	C2	129
Harlan Creek Lake #1	1151400445303	07-0980	C2	301
Harlan Creek Lake #2	1151481445220	07-0983	C2	241
Hasbrook Lake #1	1151786445219	07-0992	C2	371
Helldiver Lake	1151724445350	07-0989	C2	542
Hidden Lake	1146759454772	07-1573	C2	241
Hindman Lake #1	1145515442311	07-1495	C2	496
Imogene Lake #1	1149513439966	07-1713	TT	1,753
Imogene Lake #2	1149601439991	07-1714	C2	201
Imogene Lake #3	1149639439897	07-1715	C2	622
Imogene Lake #4	1149672439895	07-1717	C2	100
Imogene Lake #6	1149730439892	07-1719	C2	522
Iris Lake #1	1151136443041	07-1074	C2	221
Iris Lake #3	1152023445170	07-1077	C2	341

Table 2. (continued)

Lake	LLID	Catalog #	Species	# of fish
Iron Creek Lake #6	1150367441642	07-1547	TT	76
Iron Creek Lake #7	1150434441672	07-1548	TT	76
Island Lake	1151425444755	07-1127	TT	1,563
Kidney Lake #2	1149724445226	07-1033	C2	151
Langer Lake #1	1151347444803	07-1133	TT	1,004
Lost Lake	1151596445294	07-0988	C2	201
Lower Island Lake	1151399444776	07-1129	C2	542
Lower Valley Creek Lake	1150375443726	07-1584	C2	542
Lucille Lake	1149687440054	07-1708	C2	769
Marshall Lake #2	1149960441553	07-1525	C2	494
Martha Lake	1150956442871	07-1569	C2	201
McGowan Lake #3	1150760441778	07-1565	C2	259
Muskeg Lake #1	1152100445438	07-1043	TT	497
Muskeg Lake #3	1152187445407	07-1046	TT	497
P-38 Lake	1150727443980	07-1160	C2	319
Parks Peak Lake #1	1149425439593	07-1745	C2	497
Profile Lake	1149737440151	07-1710	C2	776
Ruffneck Lake	1151473444730	07-1130	TT	1,249
Soldier Lake #4	1151941445301	07-1050	C2	974
Soldier Lake #7	1151989445294	07-1055	C2	241
Solider Lake #10	1152032445309	07-1059	C2	244
Solider Lake #11	1152031445337	07-1060	C2	244
Solider Lake #8	1152017445263	07-1057	C2	244
Thompson Cirque Lake	1150019441447	07-1604	C2	893
Upper Cramer	1145909440146	07-1657	C2	494
Upper Hell Roaring #1	1149516440275	07-1687	C2	259
Upper Hell Roaring #2	1149599440307	07-1688	C2	259
Upper Redfish Lake #2	1150360440459	07-1635	C2	422
Upper Redfish Lake #3	1150363440398	07-1636	C2	619
Valley Creek Lake #2	1149534443724	07-1587	C2	394
Vanity Lake #1	1150528444936	07-1009	TT	304
Vanity Lake #4	1150493444883	07-1014	TT	253
Vanity Lake #5	1150560444885	07-1015	C2	118
Vanity Lake #7	1150648444848	07-1017	TT	203

[a] LLID = Latitude and Longitude Identification
[b] C2=Westslope Cutthroat Trout, TT=Triploid Rainbow Trout, GR=Arctic Grayling, and GN=Golden Trout.

Table 3. Rotation C high mountain lakes surveyed in 2015 (n = 37), including location (LLID), elevation, estimated maximum depth, hiking distances, estimated level of human use, and amphibian species observed.

Drainage/ lake name	LLID [a]	Elevation (m)	Maximum depth (m)	Trail distance (mi)	Cross-country distance (mi)	# campsites	Human use	Amphibian species present [b]
Lemhi River								
Basin Creek Lake #4 (McNutt)	1138488448272	2787	n/t	8.0	8.0	3	Mod	none
Basin Creek Lake #5	1138550448415	2711	6.5	4.8	0.0	1	Mod	LTS
Bear Valley Lake #3	1138585448175	2813	3.1	18.0	0.0	3	Mod	none
Buck Lake #4	1138529447819	2885	6.7	10.1	3.2	2	Mod	none
Everson Lake	1136134446256	2710	15.6	7.1	0.0	3	Mod	none
Nez Perce Lake	1133908445099	2691	3.7	6.4	0.0	1	Mod	LTS
R F Big Eightmile Lake	1136089445897	2756	6.5	11.6	0.0	2	Low	LTS
Upper mainstem Salmon River								
M F Hat Creek Lake #2	1142104448747	2715	4.6	7.7	1.3	0	None	CSF, LTS
M F Hat Creek Lake #3	1142044448775	2691	6.2	7.7	0.0	4	Low	none
M F Hat Creek Lake #4	1142040448793	2690	10.9	7.7	0.0	3	Low	LTS
M F Hat Creek Lake #5	1142101448782	2721	12.1	9.0	0.0	2	Low	none
N F E F Reynolds Lake #2	1145482455479	2323	11.4	5.1	1.3	1	Mod	CSF
N F E F Reynolds Lake #4	1145447455576	2299	11.4	5.1	0.0	2	Mod	none
S F Moyer Creek Lake	1142310448846	2660	7.4	7.7	4.0	3	Low	CSF
U P Lake	1140147452354	2456	9.8	18.2	0.0	1	High	CSF
Middle Fork Salmon River								
Finger Lake #3	1151499444898	2469	10.9	10.3	1.3	1	Low	none
Knapp Lake #7	1149238444228	2541	7.1	11.4	4.5	0	Low	CSF
Knapp Lake #14	1149411444341	2556	6.7	13.8	1.1	0	Low	CSF
Lola Lake #2	1152248443910	2445	6.5	8.7	0.8	1	Low	CSF, LTS
Lola Lake #3	1152402443907	2604	5.9	10.9	0.8	3	Low	LTS
Loon Creek Lake #3	1149282444426	2516	28.0	23.3	2.3	2	Low	LTS
Loon Creek Lake #11	1149496444671	2606	2.6	20.9	2.7	2	Low	none
Loon Creek Lake #13	1149456444909	2531	2.5	14.5	4.8	0	Low	none
Loon Creek Lake #15	1149426444965	2472	5.1	14.5	4.8	0	Low	CSF
Rocky Lake	1151353444863	2507	5.0	4.7	1.1	1	Low	none
Tango Lake #4	1148984444467	2662	15.2	23.2	9.0	0	Low	none
Tango Lake #5	1148931444432	2576	3.4	11.6	9.5	3	Low	none
Tango Lake #6	1148967444401	2637	>8.4	11.6	7.9	0	Low	none
Pahsimeroi River								
Pass Lake	1137575440901	3071	17.6	9.0	1.3	1	Low	none
Patterson Lake #2	1136561446259	2802	4.8	12.9	7.7	1	Low	none

Table 3. (continued)

Drainage/ lake name	LLID [a]	Elevation (m)	Maximum depth (m)	Trail distance (mi)	Cross-country distance (mi)	# campsites	Human use	Amphibian species present [b]
Patterson Lake #3	1136538446355	2726	2.7	12.9	9.0	0	None	none
Yellow Peak Lake	1135408445340	2825	2.9	14.8	1.3	2	Low	LTS
Yankee Fork Salmon River								
Cabin Creek Lake #3	1149032444206	2702	3.1	12.9	7.4	0	Low	none
Cabin Creek Lake #4	1148916444210	2540	n/t	12.9	9.0	2	Low	none
Cabin Creek Lake #7	1148889444145	2615	3.8	12.9	10.3	0	Low	none
Cabin Creek Peak Lake #1	1149156444024	2507	4.3	18.8	0.5	0	None	none
Hindman Lake #1	1149217443864	2457	9.9	0.0	0.0	2	Mod	CSF

[a] LLID = Latitude and Longitude Identification
[b] CSF = Columbia Spotted Frog, LTS = Long-toed Salamander

Table 4. High mountain lakes surveyed in 2015 that are not stocked on rotation C (n = 39). Includes location (LLID), elevation, estimated maximum depth, hiking distances, estimated level of human use, and amphibian species observed.

Drainage/ lake name	LLID	Elevation (m)	Maximum depth (m)	Trail distance (mi)	Cross-country distance (mi)	# campsites	Human use	Amphibian species present
Lemhi River								
Basin Creek Lake #1	1138485448501	2593	6.1	1.0	1.0	0	None	LTS
Basin Creek Lake #2	1138544448438	2729	0.5	5.6	0.3	0	None	CSF, LTS
Bear Valley Lake #1	1138702448026	2785	42.1	10.7	0.0	6	Mod	none
Buck Lake #1A	1138365447858	2616	dry	6.3	0.4	0	None	none
Buck Lake #2	1138413447865	2700	1.9	6.3	0.8	0	None	none
Buck Lake #4A	1138504447751	2898	0.3	6.3	1.1	0	None	none
Buck Lake #4B	1138484447762	2886	0.2	6.3	0.9	0	None	none
R F Big Eightmile Lake #A	1136133445917	2867	3.0	7.2	0.8	0	None	none
Upper mainstem Salmon River								
M F Hat Creek Lake #1	1142029448744	2670	1.7	5.2	0.0	5	Mod	CSF
M F Hat Creek Lake #1A	1142061448751	2694	0.9	4.8	0.3	0	None	CSF, LTS
M F Hat Creek Lake #4A	1141964448770	2638	<1.0	4.8	0.0	0	None	CSF, LTS
M F Hat Creek Lake #4B	1141903448754	2608	2.9	4.8	0.4	0	Low	CSF, LTS
M F Hat Creek Lake #4C	1142024448817	2740	0.9	4.8	0.0	0	None	none
N F E F Reynolds Lake #4A	1145438455567	2297	1.0	3.2	0.1	0	None	CSF
Spruce Gulch Lake	1144515446044	2699	13.5	4.7	0.0	2	Low	none
Middle Fork Salmon River								
Knapp Lake #3	1149412444231	2420	<1.0	7.1	1.7	0	None	none
Knapp Lake #4	1149363444262	2508	<1.0	7.1	2.5	0	None	none
Knapp Lake #5	1149350444207	2483	4	7.1	2.5	0	None	CSF
Knapp Lake #5C	1149356444185	2485	<1.0	7.1	2.6	0	None	CSF
Knapp Lake #6	1149286444238	2533	<1.0	7.1	2.3	0	None	CSF
Knapp Lake #7A	1149256444247	2541	<1.0	6.4	0.8	0	None	CSF
Knapp Lake #8	1149155444227	2641	<1.0	6.4	0.9	0	None	CSF, LTS
Knapp Lake #9	1149169444258	2630	0.9	6.4	1.1	0	None	CSF
Knapp Lake #10	1149209444288	2635	<1.0	6.4	1.1	0	None	CSF
Knapp Lake #11	1149233444317	2614	1.0	6.4	1.6	0	None	CSF
Knapp Lake #11A	1149226444276	2619	0.9	6.4	1.6	0	None	CSF
Knapp Lake #12	1149303444286	2519	<1.0	6.4	1.6	0	None	CSF
Knapp Lake #13	1149375444327	2572	<1.0	6.4	3.2	0	None	CSF
Knapp Lake #14A	1149395444326	2552	<1.0	8.6	1.0	0	None	CSF
Knapp Lake #15	1149445444321	2508	<1.0	8.6	0.7	0	None	none

Table 4. (continued)

Drainage/ lake name	LLID	Elevation (m)	Maximum depth (m)	Trail distance (mi)	Cross-country distance (mi)	# campsites	Human use	Amphibian species present
Knapp Lake #16	1149468444346	2533	<1.0	8.6	0.2	0	None	CSF
Knapp Lake #17	1149484444358	2533	<1.0	8.6	0.1	0	None	CSF
Loon Creek Lake #14	1149426444923	2496	0.9	9.0	2.8	0	None	CSF
Yankee Fork Salmon River								
Cabin Creek Lake #2	1149033444207	2703	1.9	8.0	5.8	0	None	CSF
Cabin Creek Lake #7A	1148868444173	2677	<1.0	8.0	6.6	0	None	LTS
Cabin Creek Peak Lake #2	1149222444052	2556	<1.0	11.7	0.0	0	None	none
Cabin Creek Peak Lake #3	1149203444056	2556	<1.0	11.7	0.2	0	None	none
Hindman Lake #2	1149222443836	2495	1.9	0.2	0.0	0	None	CSF
Hindman Lake #3	1149274443873	2507	3.9	0.7	0.0	0	None	CSF

[a] LLID = Latitude and Longitude Identification
[b] CSF = Columbia Spotted Frog, LTS = Long-toed Salamander

Table 5. Fish population structure and abundance in high mountain lakes, surveyed in 2015, where fish were found (n = 38). Includes current stocking information, fish species, size structure, and relative abundances observed during surveys, mean length at age 2 when available, and whether or not natural reproduction is suspected.

Drainage/ lake name	Current fish species stocked	Current stocking density (fish/ha)	Fish species present	# caught	CPUE (fish/hr) Angling/Gill netting	Mean TL (range) (mm)	Mean length at age 2	Nat repro?
Lemhi River								
Basin Creek Lake #4 (McNutt)	WCT	147	WCT	13	0.00/1.08	278 (162-383)	N/A	Y
			WCTxRBT	8	2.67/0.67	202 (150-351)	N/A	Y
Basin Creek Lake #5	WCT	208	WCT	5	--/0.36	286 (225-365)	N/A	Y
			RBT	9	--/0.64	256 (187-346)	191	Y
			WCTxRBT	5	--/0.35	283 (181-381)	N/A	Y
Bear Valley Lake #1	none	n/a	WCT	1	--/0.06	365	N/A	Y
			RBT	13	--/0.81	239 (157-360)	N/A	Y
			WCTxRBT	2	--0.13	159, 180	N/A	Y
Bear Valley Lake #3	WCT	130	WCT	15	--/0.94	237 (173-308)	215	Y
Buck Lake #4	GRA	187	GRA	28	4.00/2.07	233 (160-267)	213	Y
Everson Lake	WCT	141	RBT	37	--/1.54	201 (89-273)	181	Y
			WCTxRBT	9	--/0.38	183 (159-197)	191	Y
Nez Perce Lake	GRA	83	GRA	99	6.40/6.60	181 (95-265)	150	Y
R F Big Eightmile Lake	WCT	88	WCT	4	10.00/0.33	224 (102-286)	N/A	Y
Upper mainstem Salmon River								
M F Hat Creek Lake #1	none	n/a	WCT	8	--/1.28	260 (146-337)	N/A	Y
			GRA	1	--/0.16	311	N/A	?
M F Hat Creek Lake #3	RBT	487	RBT	8	1.33/0.66	203 (168-241)	208	Y
M F Hat Creek Lake #4	RBT	358	RBT	1	--/0.12	508	N/A	Y
M F Hat Creek Lake #5	WCT	228	WCT	14	--/0.81	224 (108-324)	N/A	?
N F E F Reynolds Lake #2	WCT	235	WCT	12	1.30/0.14	349 (292-406)	N/A	?
N F E F Reynolds Lake #4	WCT	394	WCT	10	4.00/0.65	275 (210-337)	N/A	Y
S F Moyer Creek Lake	GRA	98	WCT	9	1.00/0.48	248 (89-406)	N/A	Y
			RBT	3	0.00/0.16	320 (292-343)	N/A	Y
			WCTxRBT	1	0.00/0.05	318	N/A	Y
Spruce Gulch Lake	none	n/a	EBT	7	--/0.23	231 (152-311)	N/A	Y
			TM	1	--/0.00	~650	N/A	N
U P Lake	WCT	640	WCT	4	--/0.32	377 (299-413)	299	N
Middle Fork Salmon River								
Finger Lake #3	WCT	120	WCT	10	0.33/0.65	306 (165-445)	286	Y

Table 5. (continued)

Drainage/ lake name	Current fish species stocked	Current stocking density (fish/ha)	Fish species present	# caught	CPUE (fish/hr) Angling/Gill netting	Mean TL (range) (mm)	Mean length at age 2	Nat repro?
Knapp Lake #7	WCT	120	WCT	15	--/0.98	256 (168-304)	248	Y
Knapp Lake #14	GRA	190	GRA	24	--/1.58	300 (228-424)	286	Y
Lola Lake #2	WCT	390	WCT	3	2.50/0.16	326 (306-338)	374	?
Lola Lake #3	WCT	387	WCT	3	6.00/0.21	308 (285-343)	N/A	?
Loon Creek Lake #3	WCT	133	WCT	21	10.50/0.72	280 (122-350)	122	Y
Loon Creek Lake #11	WCT	124	WCT	3	--/0.20	412 (382-466)	N/A	?
Loon Creek Lake #13	WCT	133	WCT	12	--/0.76	274 (206-396)	237	Y
Loon Creek Lake #15	WCT	128	WCT	42	20.00/2.93	177 (87-329)	119	Y
Rocky Lake	WCT	120	WCT	3	0.00/0.23	395 (349-432)	N/A	?
Tango Lake #4	WCT	121	WCT	16	1.00/0.53	242 (104-355)	104	Y
Tango Lake #5	WCT	122	WCT	22	44.2/1.47	180 (95-244)	142	Y
Tango Lake #6	WCT	124	WCT	8	0.00/0.49	313 (84-410)	N/A	Y
Pahsimeroi River								
Pass Lake	GN	85	GN	2	0.00/0.14	292 (243-342)	N/A	N
Patterson Lake #2	WCT	117	WCT	13	23.88/0.74	247 (191-282)	191	Y
Yellow Peak Lake	WCT	505	WCT	17	--/1.13	189 (108-241)	157	Y
Yankee Fork Salmon River								
Cabin Creek Lake #3	WCT	890	WCT	16	--/0.99	239 (157-309)	234	Y
Cabin Creek Lake #4	WCT	16	WCT	13	--/0.87	225 (145-357)	223	Y
Cabin Creek Lake #7	WCT	136	WCT	11	--/0.65	189 (168-210)	192	Y
Cabin Creek Peak Lake #1	WCT	105	WCT	1	--/0.05	276	N/A	N
Hindman Lake #1	WCT	152	WCT	36	--/2.26	261 (156-353)	N/A	Y

Table 6. List of stocking recommendations for high mountain lakes in 2016 as a result of 2015 surveys.

Drainage/ lake name	Current fish species stocked	Current stocking density (fish/ha)	# stocked	Recommended change	Recommended species	Recommended stocking density (fish/ha)	# to be stocked in 2016
<u>Lemhi River</u>							
Basin Creek Lake #4 (McNutt)	WCT	147	414	none	WCT	147	414
Basin Creek Lake #5	WCT	208	1129	none	WCT	208	1129
Bear Valley Lake #1	none	n/a	none	add WCT	WCT	120	1500
Bear Valley Lake #3	WCT	130	150	halt stocking	none	0	0
Buck Lake #4	GRA	187	238	halt stocking	none	0	0
Everson Lake	WCT	141	1500	halt stocking	none	0	0
Nez Perce Lake	GRA	83	250	halt stocking	none	0	0
R F Big Eightmile Lake	WCT	88	143	halt stocking	none	0	0
<u>Upper mainstem Salmon River</u>							
M F Hat Creek Lake #1	none	n/a	none	add GRA	GRA	210	250
M F Hat Creek Lake #2	GRA	273	500	none	GRA	273	500
M F Hat Creek Lake #3	RBT	487	1031	none	RBT	487	1031
M F Hat Creek Lake #4	RBT	358	437	none	RBT	358	437
M F Hat Creek Lake #5	WCT	228	1087	halt stocking	none	0	0
N F E F Reynolds Lake #2	WCT	235	1307	none	WCT	235	1307
N F E F Reynolds Lake #4	WCT	394	999	none	WCT	394	999
S F Moyer Creek Lake	GRA	98	226	halt stocking	none	0	0
Spruce Gulch Lake	none	n/a	none	add WCT	WCT	327	1448
U P Lake	WCT	640	1006	increase WCT	WCT	959	1506
<u>Middle Fork Salmon River</u>							
Finger Lake #3	WCT	120	472	none	WCT	120	472
Knapp Lake #7	WCT	120	198	none	WCT	120	198
Knapp Lake #14	GRA	190	250	none	GRA	190	250
Lola Lake #2	WCT	390	500	none	WCT	390	500
Lola Lake #3	WCT	387	500	none	WCT	387	500
Loon Creek Lake #3	WCT	133	148	none	WCT	133	148
Loon Creek Lake #11	WCT	124	171	increase WCT	WCT	269	371
Loon Creek Lake #13	WCT	133	229	none	WCT	133	229
Loon Creek Lake #15	WCT	128	171	halt stocking	none	0	0
Rocky Lake	WCT	120	457	none	WCT	120	457
Tango Lake #4	WCT	121	667	none	WCT	121	667
Tango Lake #5	WCT	122	247	halt stocking	none	0	0
Tango Lake #6	WCT	124	889	none	WCT	124	889

Table 6. (continued)

Drainage/ lake name	Current fish species stocked	Current stocking density (fish/ha)	# stocked	Recommended change	Recommended species	Recommended stocking density (fish/ha)	# to be stocked in 2016
Pahsimeroi River							
Pass Lake	GN	85	387	add WCT	GN/WCT	85/67	387/300
Patterson Lake #1	none	n/a	none	stock WCT	WCT	176	150
Patterson Lake #2	WCT	117	200	halt stocking	none	0	0
Patterson Lake #3	WCT	126	129	none	WCT	126	129
Yellow Peak Lake	WCT	505	300	halt stocking	none	0	0
Yankee Fork Salmon River							
Cabin Creek Lake #3	WCT	890	615	reduce stocking	WCT	167	115
Cabin Creek Lake #4	WCT	16	102	none	WCT	16	102
Cabin Creek Lake #7	WCT	136	205	increase WCT	WCT	165	305
Cabin Creek Peak Lake #1	WCT	105	148	increase WCT	WCT	176	248
Hindman Lake #1	WCT	152	500	none	WCT	152	500

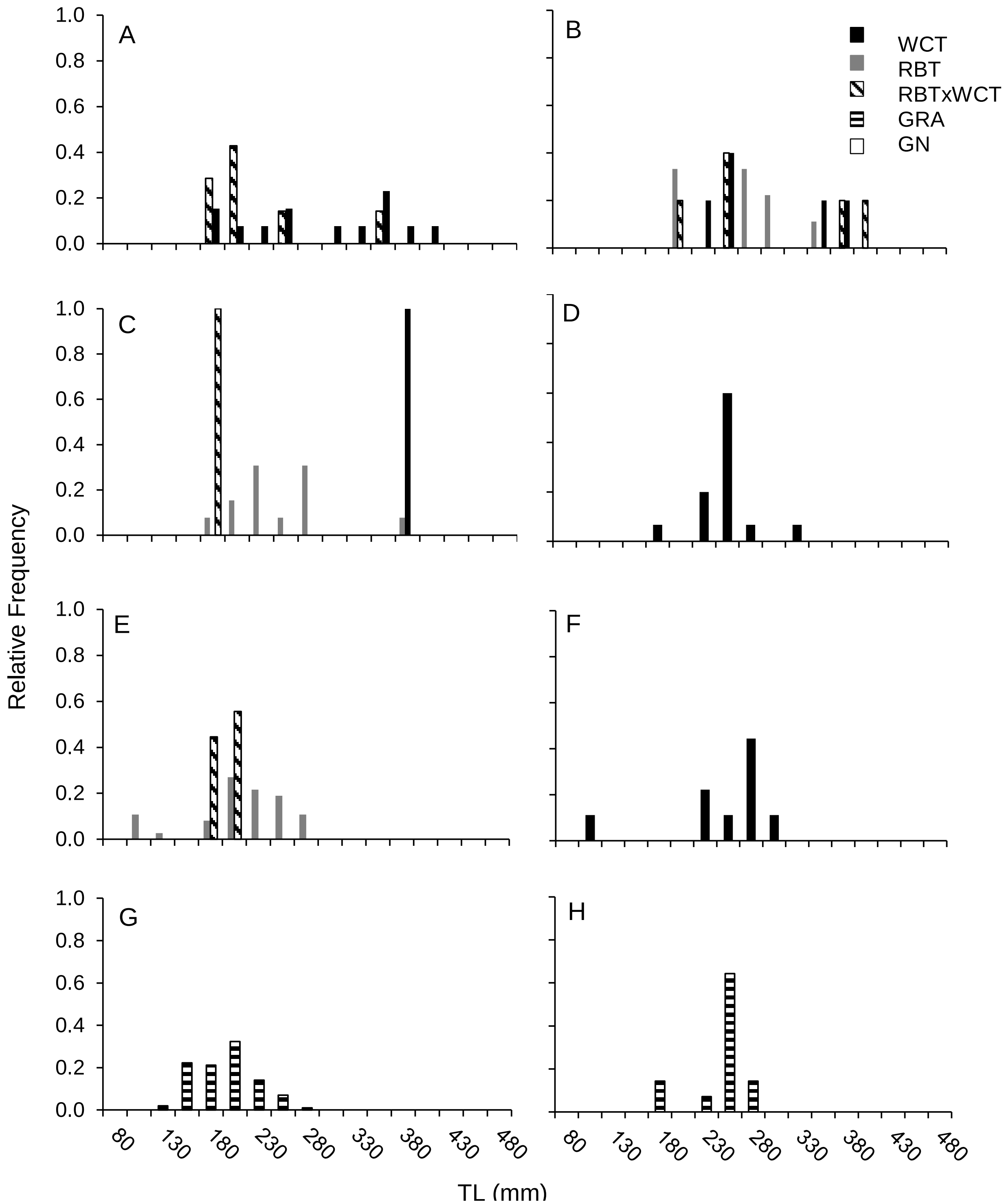


Figure 1. Length-frequency histograms of total length of all fish captured at lakes within the Lemhi River Basin during gill netting and angling sampling events (A= McNutt Lake, B= Basin Lake, C= Bear Valley Lake #1, D= Bear Valley Lake #3, E= Everson Lake, F= RF Big Eightmile Lake, G= Nez Perce Lake, and H= Buck Lake #4). Refer to table 6 for sample sizes.

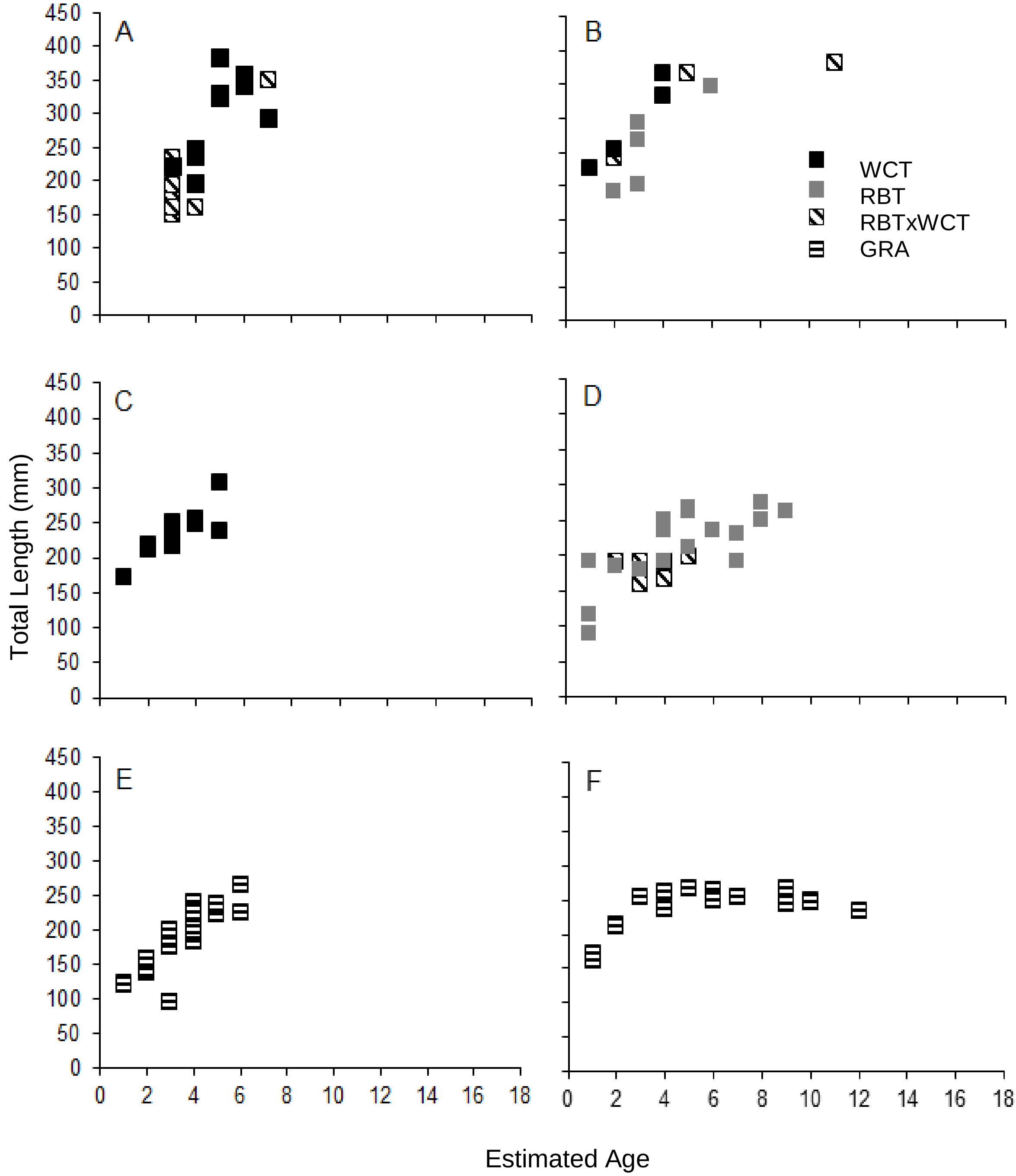


Figure 2. Length-at-age of all fish captured and aged from lakes within the Lemhi River Basin during gill netting and angling sampling events (A= McNutt Lake, B= Basin Lake, C= Bear Valley Lake #3, D= Everson Lake, E= Nez Perce Lake, and F= Buck Lake #4).

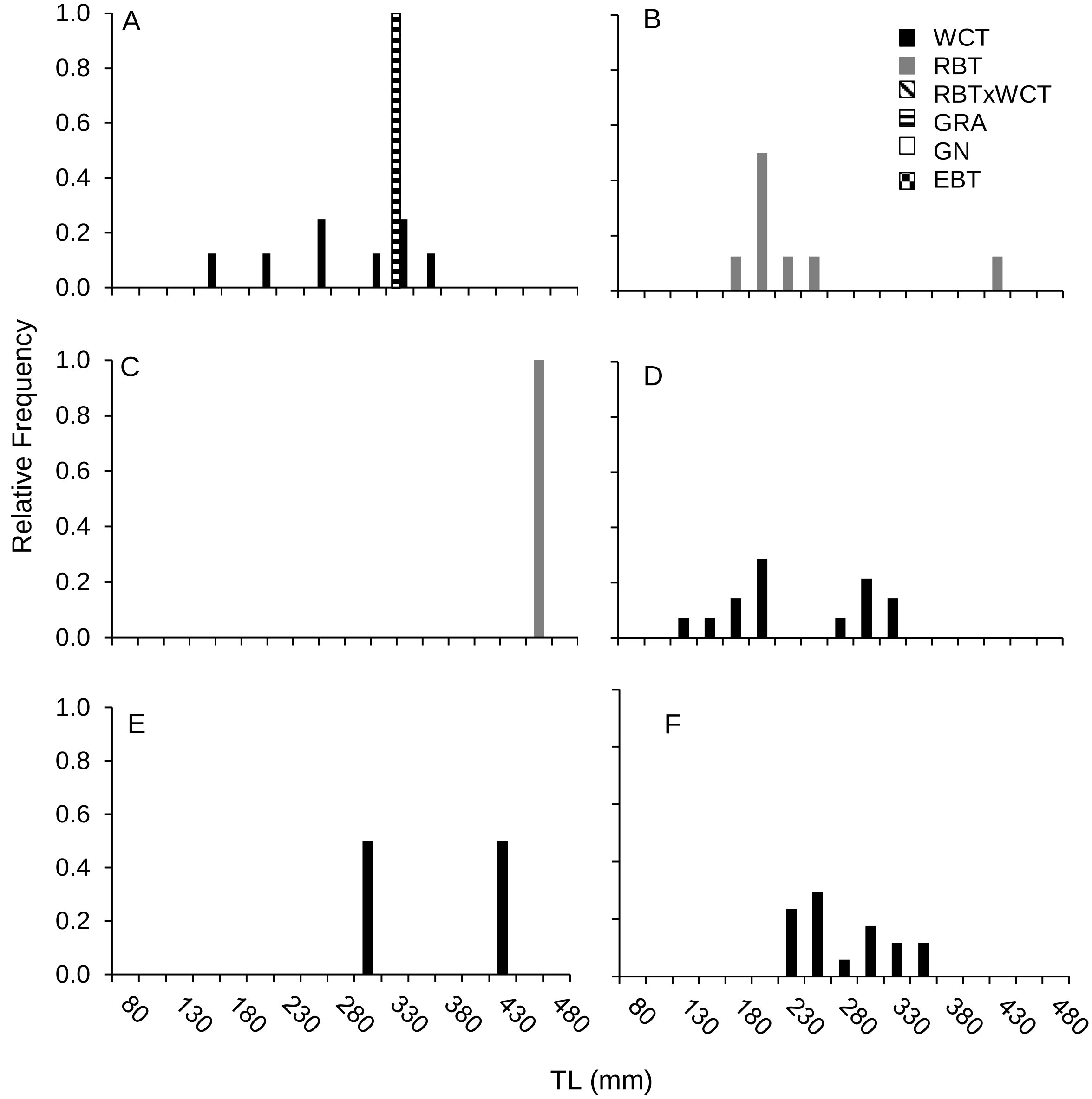


Figure 3. Length-frequency histograms of total lengths of all fish captured at lakes within the Upper Salmon River Basin during gill netting and angling sampling events (A= Hat Creek Lake #1, B= Hat Creek Lake #3, C= Hat Creek Lake #4, D= Hat Creek Lake #5, E= Reynolds Lake #2, F= Reynolds Lake #4, G= S.F. Moyer Creek Lake, H= Spruce Gulch Lake, and I= U P Lake). Refer to table 6 for sample sizes.

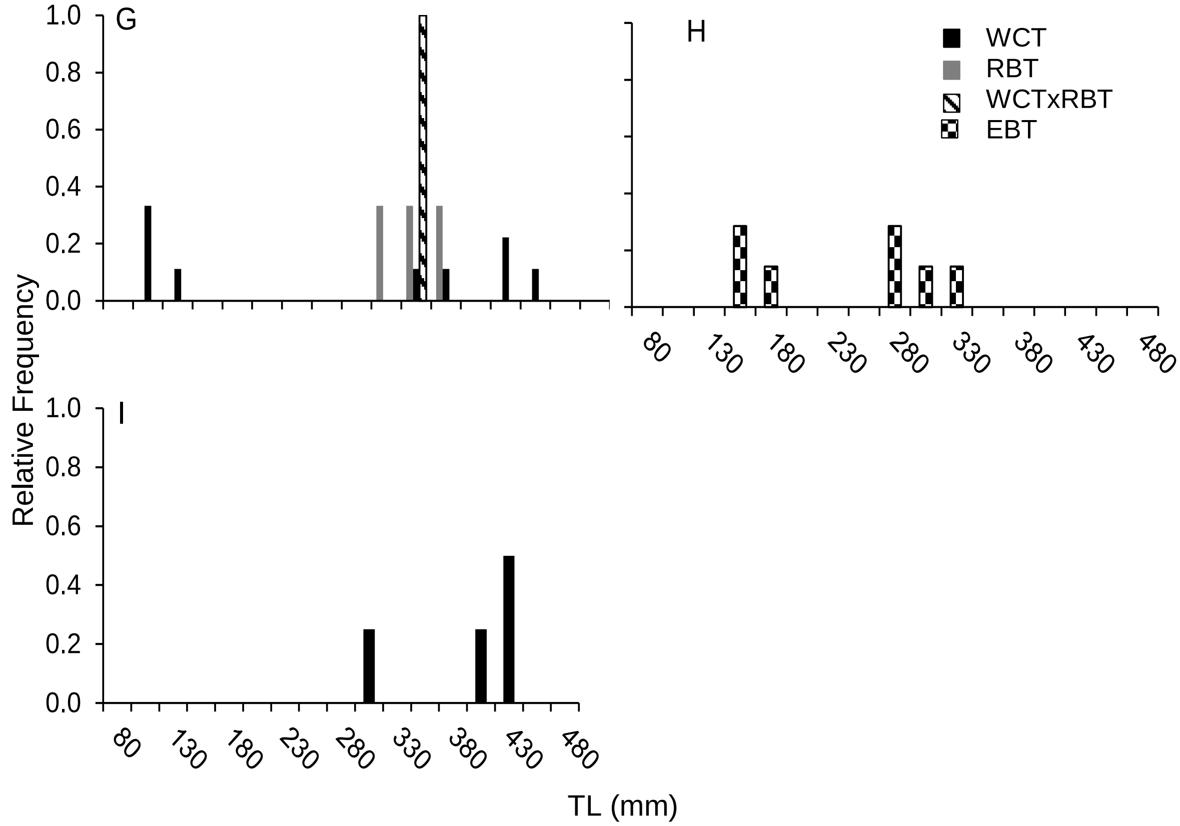


Figure 3. (continued)

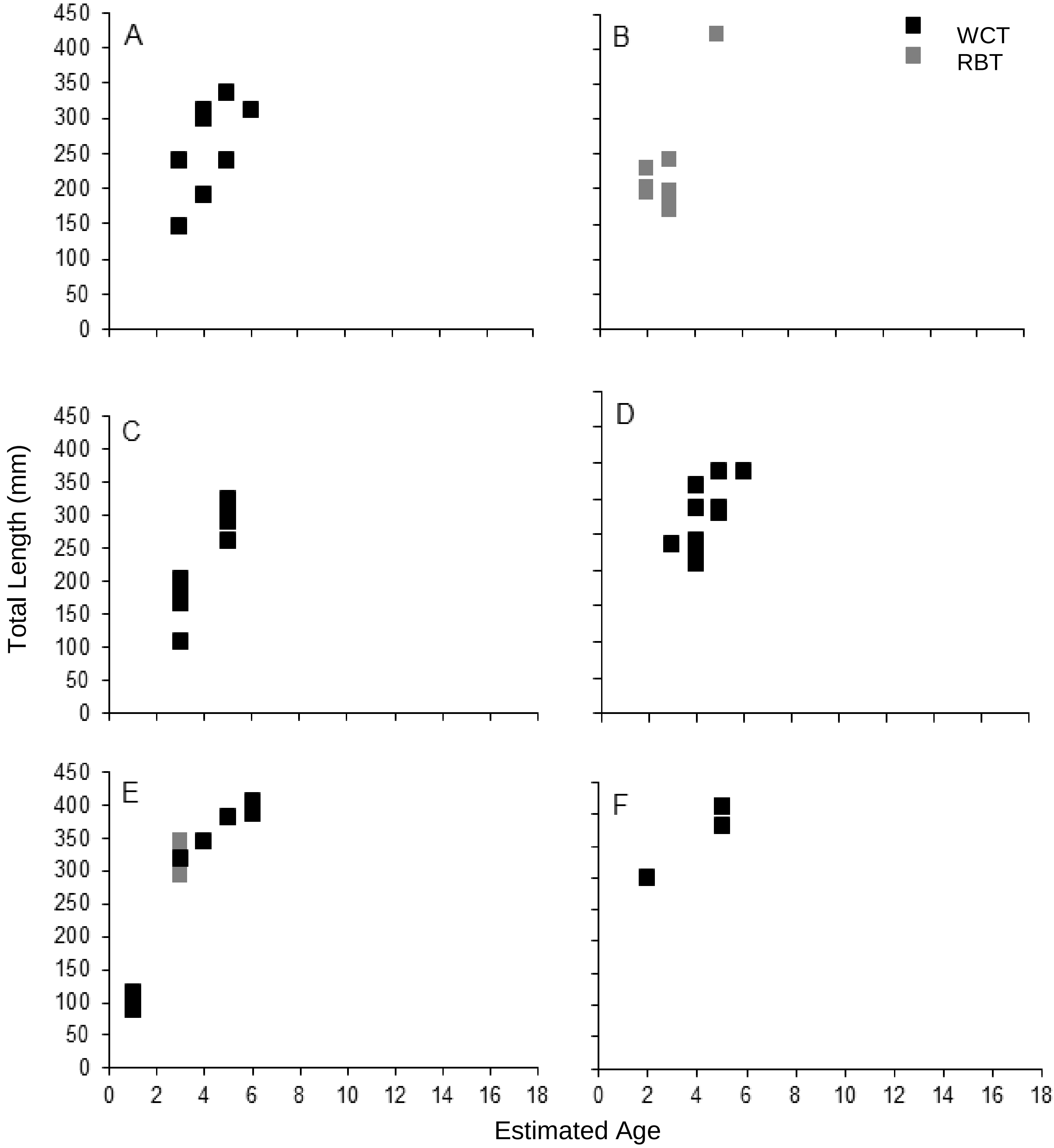


Figure 4. Length-at-age of all fish captured and aged from lakes within the Upper Salmon River Basin during gill netting and angling sampling events (A= Hat Creek Lake #1, B= Hat Creek Lake #3, C= Hat Creek Lake #5, D= Reynolds Lake #4, E= S.F. Moyer Creek Lake, and F= U P Lake).

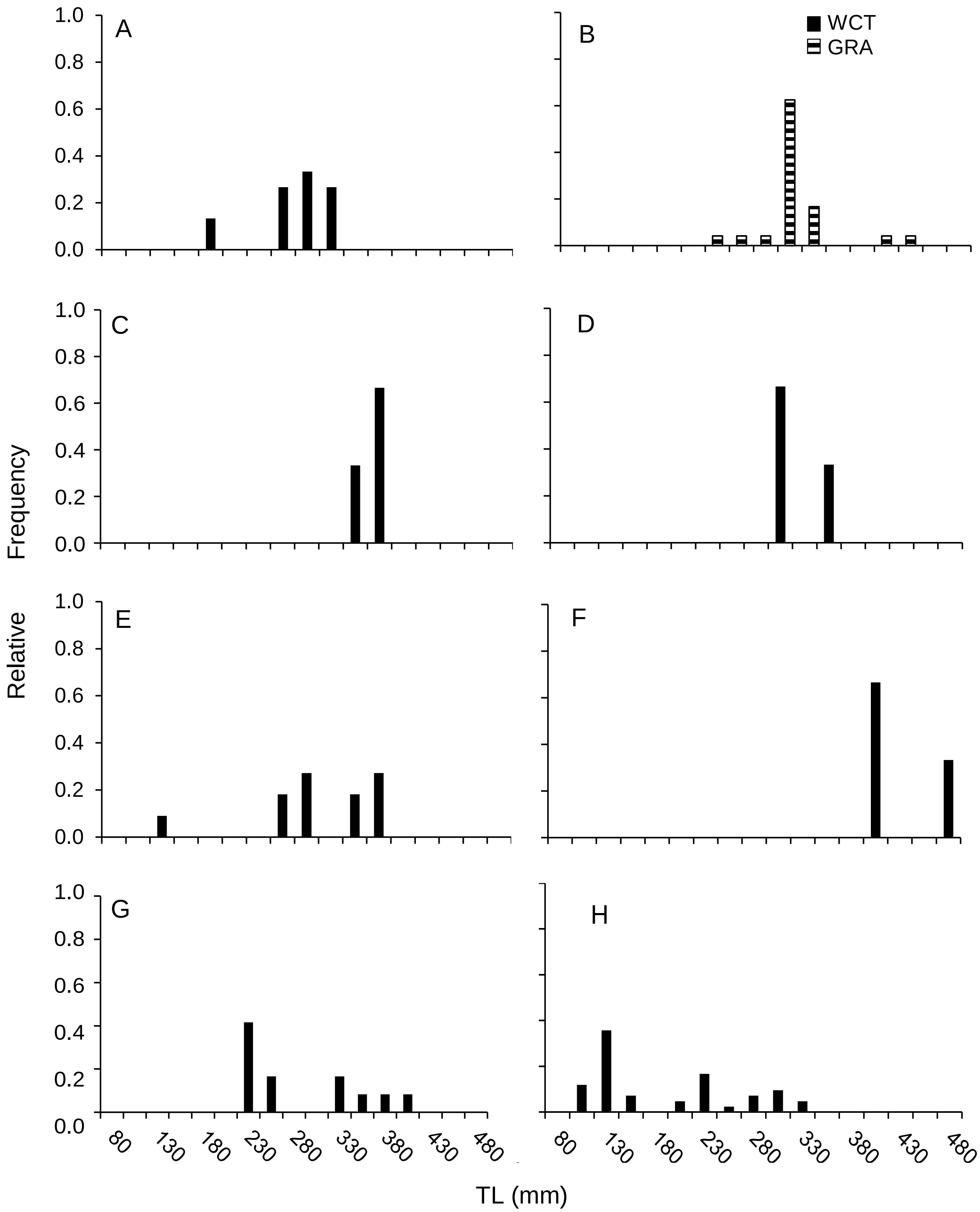
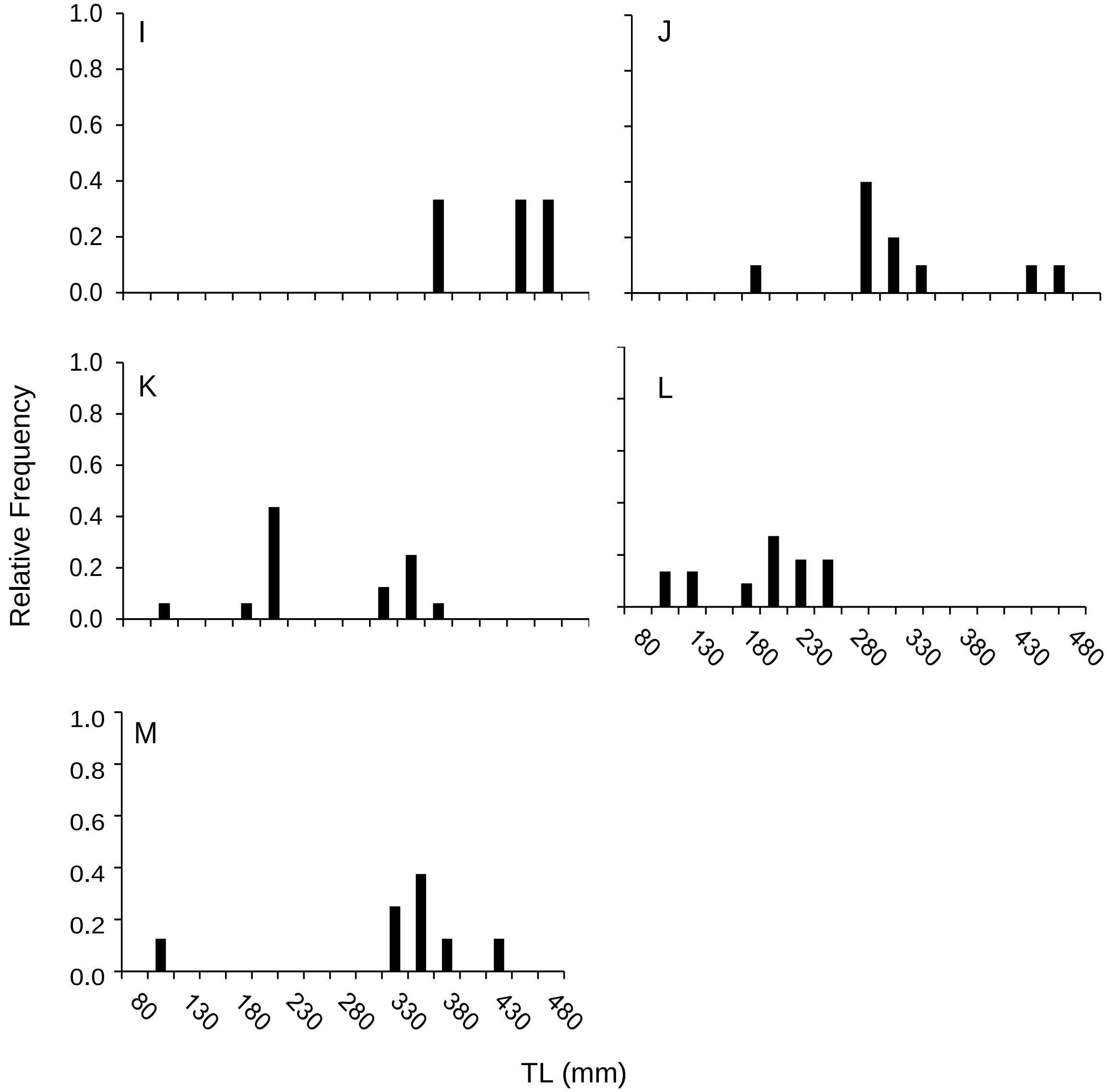


Figure 5. Length-frequency histograms of total lengths of all fish captured at lakes within the Middle Fork Salmon River Basin during gill netting and angling sampling events (A= Knapp Lake #7, B= Knapp Lake #14, C= Lola Lake #2, D= Lola Lake #3, E= Loon Lake #3, F= Loon Lake #11, G= Loon Lake #13, H= Loon Lake #15, I= Rocky Lake, J=Finger Lake #3, K= Tango Lake #4, L= Tango Lake #5, and M= Tango Lake #6). Refer to table 6 for sample sizes.



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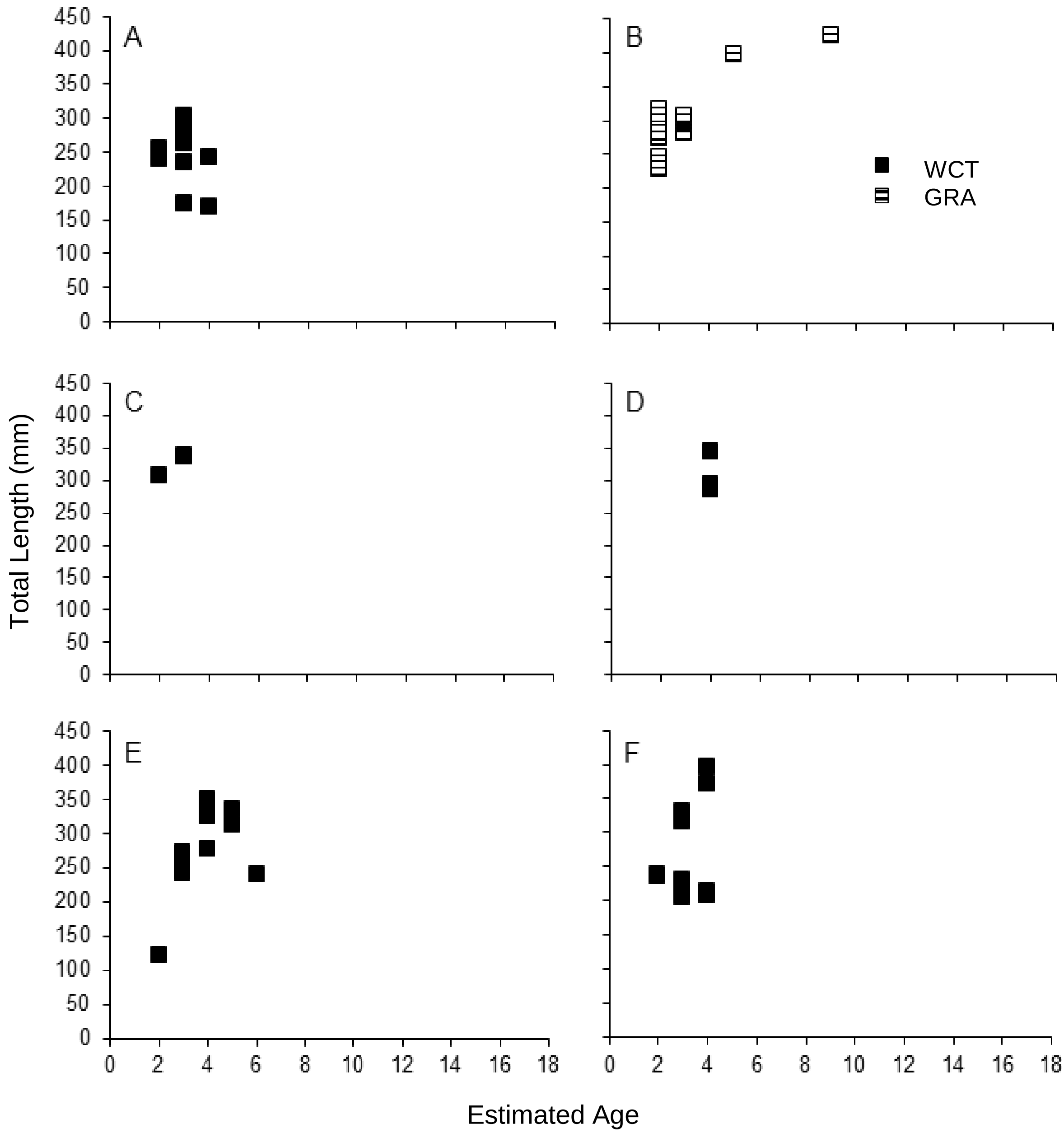

Figure 6. Length-at-age of all fish captured and aged from lakes within the Middle Fork Salmon River Basin during gill netting and angling sampling events (A= Knapp Lake #7, B= Knapp Lake #14, C= Lola Lake #2, D= Lola Lake #3, E= Loon Lake #3, F= Loon Lake #13, G= Loon Lake #15, H=Finger Lake #3, I= Tango Lake #4, J= Tango Lake #5, and K= Tango Lake #6).

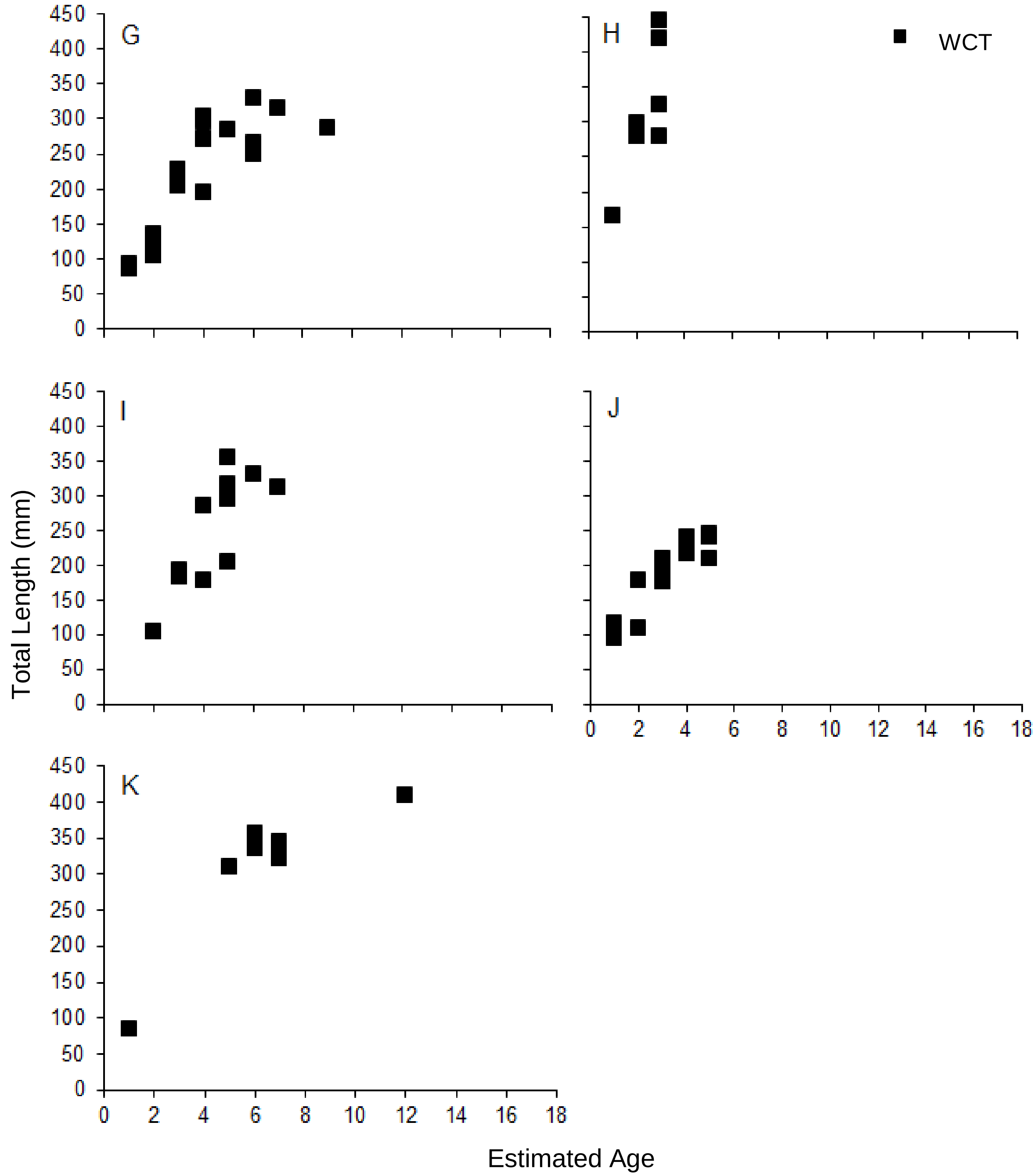

Figure 6. (continued)

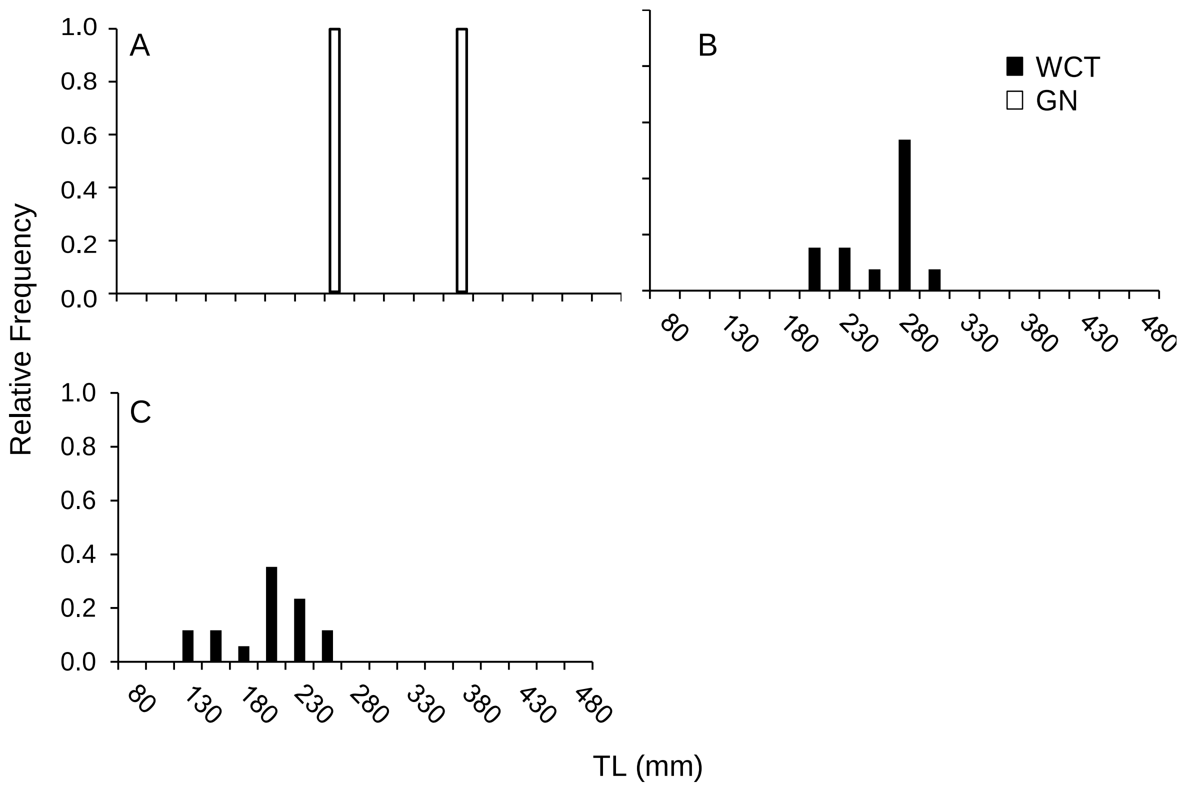

Figure 7. Length-frequency histogram of total lengths of all fish captured at lakes within the Pahsimeroi River Basin during gill netting and angling sampling events (A= Pass Lake #7, B= Patterson Lake #2, and C= Yellow Peak Lake). Refer to table 6 for sample sizes.

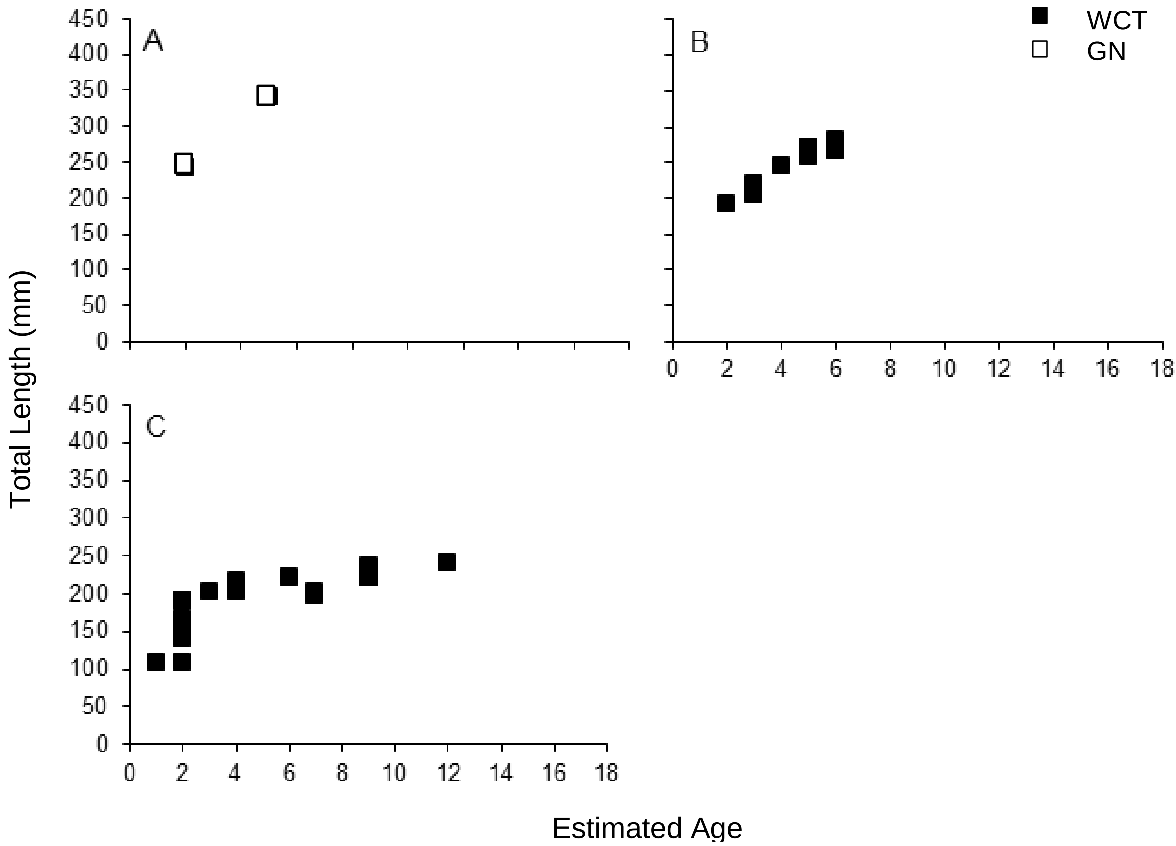

Figure 8. Lengths at ages of all fish captured and aged from lakes within the Pahsimeroi River Basin during gill netting and angling sampling events (A= Pass Lake #7, B= Patterson Lake #2, and C= Yellow Peak Lake).

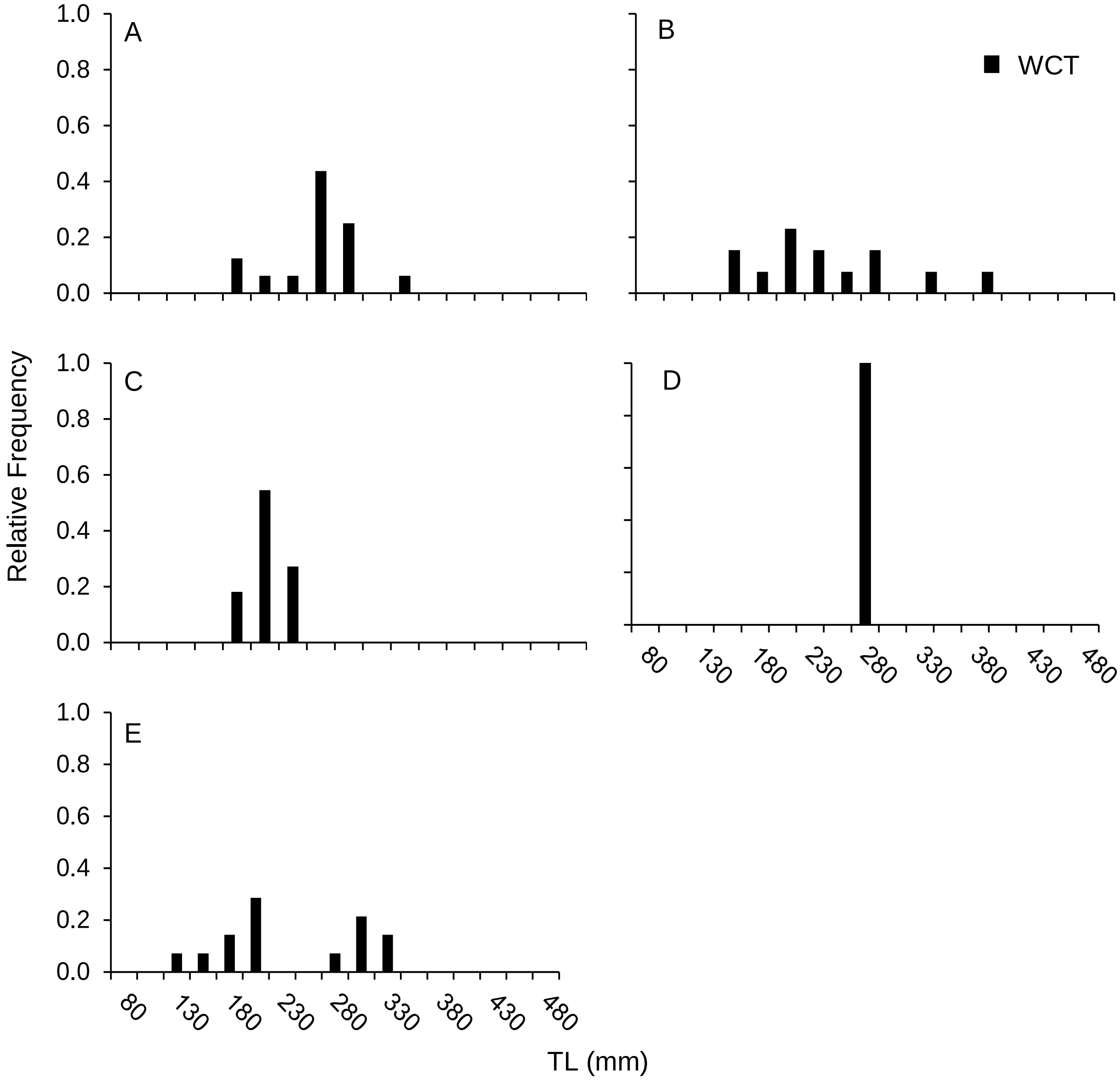

Figure 9. Length-frequency histograms of total lengths of all fish captured at lakes within the Yankee Fork Salmon River Basin during gill netting and angling sampling events (A= Cabin Creek Lake #3, B= Cabin Creek Lake #4, C= Cabin Creek Lake #7, D= Cabin Creek Peak Lake, and E= Hindman Lake #1). Refer to table 6 for sample sizes.

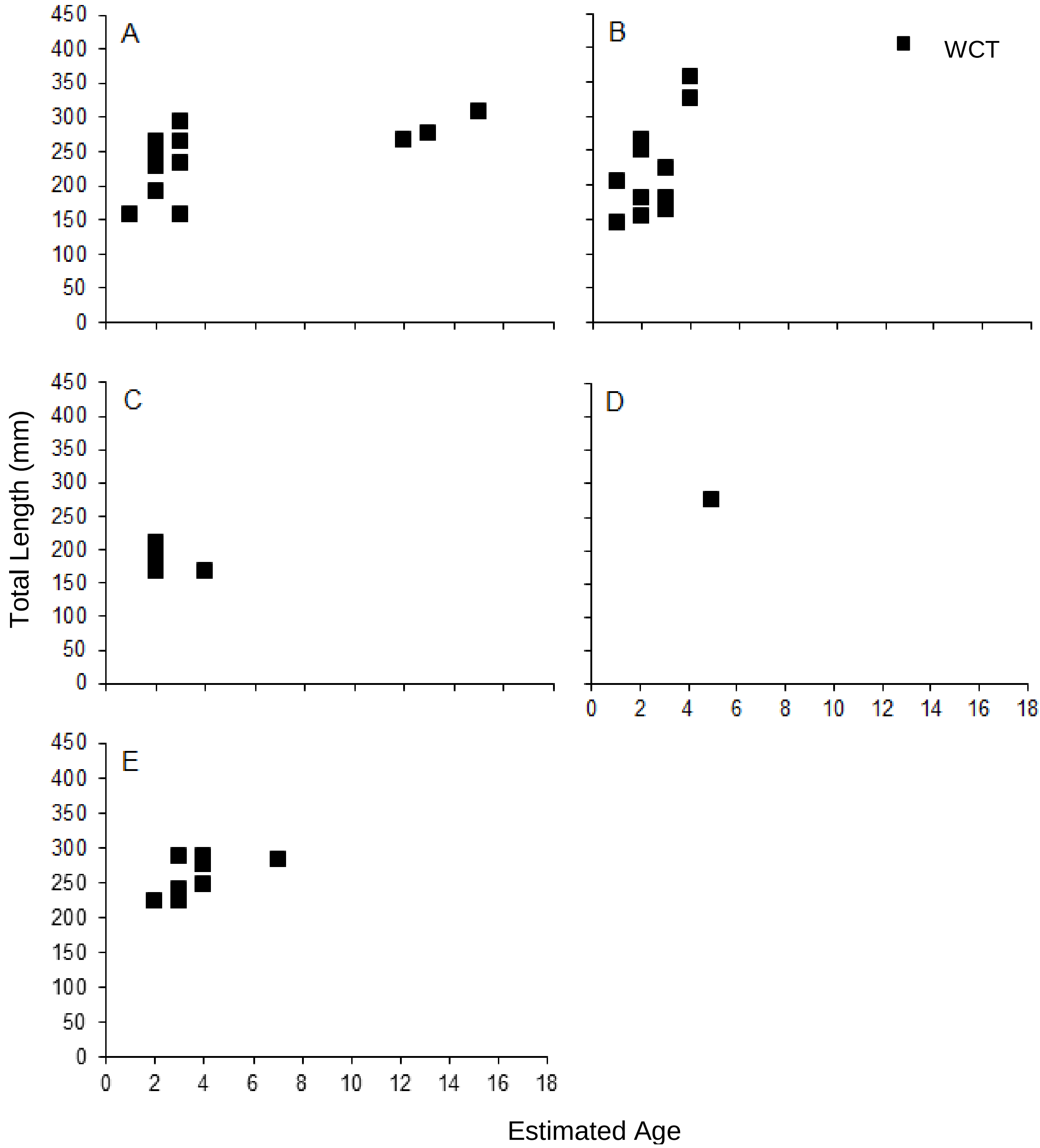

Figure 10. Length-at-age of all fish captured and aged from lakes within the Yankee Fork Salmon River Basin during gill netting and angling sampling events (A= Cabin Creek Lake #3, B= Cabin Creek Lake #4, C= Cabin Creek Lake #7, D= Cabin Creek Peak Lake, and E= Hindman Lake #1).

LOWLAND LAKES AND RESERVOIRS:

EXPLOITATION STUDIES

ABSTRACT

We assessed return-to-creel rates for stocked catchable Rainbow Trout *Oncorhynchus mykiss* (mean 250 mm TL) in six lakes in the Salmon Region in 2015, using the Tag-You're-It program (Meyer et al. 2012, Cassinelli 2014). Both, total use (fish caught) and total exploitation (fish harvested) were estimated for each lake. As of January, 2016, estimated rates for hatchery-stocked catchable Rainbow Trout were highest in Blue Mountain Pond (31.7% for both use and exploitation), and lowest in Cape Horn Lake #1 (3.0% for both use and exploitation) and Squaw Creek Pond (0.0% for both use and exploitation). Since 2011 when we began using these methods to estimate return-to-creel rates, 49.2% is the highest estimated total use we have observed in the region (Meadow Creek Lake in 2014).

In 2015 we also assessed return-to-creel rates for tiger trout *Salvelinus fontinalis x Salmo trutta* in Wallace Lake and Westslope Cutthroat Trout *Oncorhynchus clarkii* in Meadow Lake. As of January, 2016, estimated total use on these groups of fish were 20.5% and 16.6%, respectively, and estimated exploitation was 13.3% and 10.7%, respectively.

Author:

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INTRODUCTION

Hatchery production of catchable Rainbow Trout (averaging ~250 mm TL) typically accounts for over 50% of IDFG's annual Resident Hatchery budget (Cassinelli 2014), there is a need to quantify use and exploitation patterns to better inform management decisions and help guide stocking programs to maximize efficiency. IDFG research staff developed a tag reporting program in 2006, called "Tag-You're-It", to evaluate return-to-creel rates for catchable Rainbow Trout *Oncorhynchus mykiss* stocked in "put-and-take" waters (Meyer et al. 2012, Cassinelli 2014). The tagging program allows us to estimate total use (fish caught) and exploitation (fish harvested) of stocked groups, based on angler reporting of caught tags. A proportion of stocked fish during each stocking event are tagged, and use and exploitation estimates for each stocked group of fish, based on tags reported, are adjusted by factoring in estimated tag reporting rates, estimated tag-loss rates, and estimated tagging mortality rates (Cassinelli 2014).

We have been using the Tag-You're-It program to assess return-to-creel rates for stocked lakes in the Upper Salmon River Basin since 2011. Over the past four years, 11 regional lakes and ponds have been evaluated, and some have been evaluated in multiple years. We evaluated two lakes in 2011, two in 2012, three in 2013, and nine in 2014, in the Salmon Region. We also estimated return-to-creel for catchable Rainbow Trout stocked in the Salmon River in 2011, 2012, and 2013. Overall use estimates in our region have ranged as low as 0.0% and 1.4% in Hyde Pond (2014) and Alturas Lake (2014), respectively, and as high as 49.2% in Meadow Lake in 2014.

We used the Tag-You're-It program in 2015 to evaluate return-to-creel rates for stocked catchable Rainbow Trout at six put-and-take fisheries, as well as for stocked tiger trout *Salvelinus fontinalis x Salmo trutta* in Wallace Lake, and for Westsople Cutthroat Trout *Oncorhynchus clarkii* in Meadow Lake. Westslope Cutthroat Trout are stocked in Meadow Lake as fry (<76 mm TL), so fyke nets were used to capture adults for tagging, to determine how effective the fry stocking program is at producing adults that return-to-creel. Results for Meadow Lake are presented in this chapter, and results for Wallace Lake are presented in chapter three of this report (Chapter Three: Wallace Lake).

OBJECTIVES

1. Improve understanding of how anglers use regional fisheries by conducting return-to-creel evaluations.

2. Estimate return-to-creel rates hatchery trout to determine whether stocking timing, frequency, and/or densities could be adjusted to maximize angler use and satisfaction.

STUDY AREAS

Blue Mountain Pond (WGS84 datum: 44.50119 ºN, 114.23923 ºW) is a 0.27 ha community fishing pond located within the city of Challis. The pond is typically de-watered during winter months, and is filled in the spring to provide recreational fishing opportunity to the Challis community. IDFG provided in-kind matching funds (~$60,000) to build the pond in 1998, and we have been stocking the pond with ~900 to ~2,300 catchable Rainbow Trout per year since 1999. In 2015, we stocked ~300 catchable Rainbow Trout during each of three stocking events (May, June, and September) for a total of ~900 stocked catchables. Return-to-creel rates were assessed for all three stocking events in 2015.

Cape Horn Lake #1 (WGS84 datum: 44.40921ºN, 115.13368 ºW) is a 12.7 ha lake located approximately 35 km from the town of Stanley, near the confluence of Cape Horn and Beaver Creeks, at 2,000 meters in elevation. There is great access to Cape Horn Lake #1 from approximately mid-June through October, but the road is inaccessible during winter and early spring months. The lake was stocked with catchable Rainbow Trout from 1947 to 1985, but stocking was then discontinued until 2015. We stocked ~300 catchable Rainbow Trout during each of three events (June, July, and August) in 2015, and we assessed return-to-creel rates for the first two of these three events.

Little Bayhorse Lake (WGS84 datum: 44.41222ºN, 114.38805ºW) is a 6.2 ha lake located ~30 km from the city of Challis, at ~2,550 m elevation. Drive-in access to the lake is available during snow-free months, as there is a maintained road that climbs the 11.5 km up Bayhorse Creek, past the historic "ghost town" of Bayhorse, to Big and Little Bayhorse Lakes. Little Bayhorse Lake was first stocked in 1957, and IDFG currently stocks ~1,000 to ~3,000 catchable Rainbow Trout annually. In 2015, we stocked ~500 catchables during each of four events (two in June and two in July), for a total of ~2,000.

Meadow Lake (WGS84 datum: 44.43359ºN, 113.31486ºW) (also called Meadow Creek Lake) is a 7.0 ha lake located at 2,790 m elevation, ~37 km from the town of Leadore. Meadow Lake is a unique high alpine lake, because it is accessible to large vehicles, campers, and motorhomes, due to a maintained paved road that climbs the entire way to the lake and an 18-site developed campground with amenities. We currently stock ~4,000 catchable Rainbow Trout and ~6,000 Westslope Cutthroat Trout fry (<76 mm TL) per year in Meadow Lake. Fishery investigations in 2014 at Meadow Lake found that stocked catchable Rainbow Trout returned-to-creel at a very high rate (~49%) (Messner et al. 2016), but it is unknown how well Westslope Cutthroat Trout (stocked as fry) return-to-creel as adults. Adult Westslope Cutthroat Trout made up 80% of the catch composition in gill netting surveys at the lake in 2013 (Messner et al. 2016). In 2015 we wanted to determine how cutthroat return to creel to determine if current stocking strategies are effective at maintaining a diverse fishery.

Mosquito Flat Reservoir (WGS84 datum: 44.51782ºN, 114.43577ºW) is a 16.2 ha reservoir located ~27 km from the city of Challis, towards the head of Challis Creek, at 2,115 m elevation. The reservoir was created with the construction of a 18 m tall dam in 1949/1950 and has been stocked with fish regularly since 1952. In 1988, 28% volume of the reservoir was donated to Idaho Department of Fish and Game (IDFG) for recreation and fish propagation. At full pool, maximum lake depth is approximately 15 meters, and at 28% pool volume maximum depth is approximately 9 meters. Prior to IDFG's acquisition of 28% of the pool volume, the reservoir was typically dewatered throughout the course of the summer due to irrigation withdrawal. In 2010, IDFG assisted with funding on major improvements to the dam to alleviate safety concerns. The reservoir is currently stocked with ~5,500 to ~6,000 catchable Rainbow Trout per year. In 2015, ~1,000 to ~1,600 catchable Rainbow Trout were stocked during each of four stocking events at the reservoir (May, June, July, and August) for a total of ~5,600 fish.

Stanley Lake (WGS84 datum: 44.24371ºN, 115.05653ºW) is 71.3 ha in size, has a maximum depth of ~27 meters, and sits at 1,990 m in elevation in the Sawtooth Basin, near Stanley, Idaho. IDFG has been stocking Stanley Lake since the 1940's, and has been stocking hatchery Rainbow Trout there since 1956. Other species that have been stocked in the past include Sockeye and Kokanee Salmon *Oncorhynchus nerka*, and Lake Trout *Salvelinus namaycush*. The Sawtooth Basin is a popular destination for tourists during summer months, so Stanley Lake is currently managed as a put-and-take fishery to offer harvest opportunity for visiting anglers in the area. Trout limit is six per person, per day. For the past five years, Stanley

Lake has been stocked with approximately 8,000 to 20,000 catchable Rainbow Trout per year. In 2014 and 2015, Stanley Lake was included as part of a statewide research project focused on improving return-to-creel rates by altering hatchery production practices. In 2015 Stanley Lake received an equal number of ‘magnum catchables’ (mean 330 mm TL) and ‘standard’ catchable (mean 250 mm TL) Rainbow Trout, and fish from each group were tagged (~10%) to evaluate differential return-to-creel rates from the two groups.

Squaw Creek Pond (WGS84 datum: 44.25806ºN, 114.45701ºW) is a 0.6 ha pond located ~6 km from the town of Clayton, and ~32 km from the city of Challis. IDFG constructed the pond in 1997 on land donated by the Thompson Creek Mining Company. The pond was first used as an anadromous Steelhead acclimation pond, where hatchery-reared Steelhead were stocked prior to smolting. After Steelhead left the pond, non-migratory fish would remain and supported a local fishery. Currently, the pond is managed as a put-and-take fishery. The pond receives water from Squaw Creek via a diversion ditch and the outflow is diverted back into Squaw Creek. The pond is dewatered during winter months, and is re-watered in the spring to offer recreational fishing opportunity for the surrounding communities (i.e. Clayton and Thompson Creek) during summer months. We currently stock 600 to 800 catchable Rainbow Trout per year in the pond.

METHODS

Return-to-creel rates were assessed for all stocking events at Blue Mountain Pond, Bayhorse Lake, Mosquito Flat Reservoir, Little Bayhorse Lake, Stanley Lake, and Squaw Creek Pond in 2015, and were also assessed for the first two of three stocking events at Cape Horn Lake #1, for 150 captured and tagged Westslope Cutthroat Trout at Meadow Lake, and for Tiger Trout stocked in Wallace Lake (summarized in Chapter Three: Wallace Lake).

Total use (fish caught) and exploitation (fish harvested) were evaluated for hatchery-produced catchable Rainbow Trout in five water bodies, Westslope Cutthroat Trout in one water body, and tiger trout in one water body (discussed in Chapter Three of this report), in the Salmon Region in 2015. Blue Mountain Pond, Cape Horn Lake #1, Little Bayhorse Lake, Mosquito Flat Reservoir, and Squaw Creek Pond are stocked with catchable Rainbow Trout several times each year, and Wallace Lake was stocked with catchable tiger trout for the first time in 2015. For selected stocking events in 2015, 10% of stocked fish were marked with FLOY T-bar anchor tags for exploitation analysis. At Meadow Creek Lake, since Westslope Cutthroat Trout are stocked as fry (<76 mm TL), we set two fyke nets on June 9 and 10, 2015 to capture and tag 150 adults (190 to 340 mm TL) for exploitation analysis. Tags used for this study were printed with a unique numerical code and information for anglers to report caught and harvested fish (Cassinelli 2014). IDFG contact information on the tags directed anglers to report tags to the Nampa Fish Research office where the data is stored. Estimated total use and exploitation for each stocking event were calculated based on methods reported in Meyer et al. (2010). Unadjusted harvest and catch estimates were calculated for each stocking event, and adjusted by factoring in the statewide angler reporting rate estimate (58.0% in 2015), the statewide estimated tag-loss rate (2.5% for first year at large in 2015), and the estimated tagging mortality rate (constant = 0.8%) found in Cassinelli (2014). In this report, we only generated estimates for each stocking group’s first year at large. Estimates for adjusted use and exploitation (u') were calculated using the formula:

$$u' = \frac{u}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

Where:

u = unadjusted harvest/catch rate

λ = angler tag reporting rate
Tag_l = first year tag-loss rate
Tag_m = tagging mortality rate

Ninety percent (90%) confidence intervals were calculated for all harvest and catch estimates. For more information and details regarding these methods and associated formulas, see Meyer et al. (2010).

Magnum study - In 2013, IDFG began evaluating if stocking catchable Rainbow Trout at an overall larger size could be used to improve return-to-creel rates (Cassinelli 2015). At American Falls Hatchery, a group of catchable Rainbow Trout were reared to reach an average 330 mm TL before being stocked (compared to the traditional 'standard' 250 mm TL catchables). At Stanley Lake in 2015, an equal number of 'magnums' and 'standards' were stocked, and approximately 10% of each group were tagged before release to assess differences in return-to-creel between each group. For more detailed information on the 'magnum' study, see Cassinelli (2015).

RESULTS AND DISCUSSION

Blue Mountain Pond

Mackay Hatchery staff stocked 838 catchable Rainbow Trout in Blue Mountain Pond in May (n = 300), June (n = 300), and September (n = 298), 2015, and 30 fish (~10%) were tagged during each event to estimate return-to-creel on the stocked groups. As of January 2016, 16 of the tagged fish were reported as harvested (five from the May group and 11 from the June group) and none were reported caught and released (Table 7). Total use estimates for each stocked group was 29.7% for the May group, 65.4% for the June group, and 0.0% for the September group (Figure 11), for an average of 31.7% across all three groups (Figure 12).

Relative to similar community fishing ponds that were studied in 2014 (Hayden Pond, Hyde Pond, and Kids Creek Pond), return-to-creel rates at Blue Mountain Pond in 2015 were excellent (Table 8). The highest return-to-creel rate we estimated for those similar community ponds in 2014 was 23.4% (Hayden Pond). Although the annual Free Fishing Day kids' fishing derby at Blue Mountain Pond was the day after the June stocking (June 13, 2015), likely contributing to the large number of tagged fish caught and returned for that stocking event (65.4% total use), 29.7% estimated total use on the group of fish stocked in May is an excellent return as well. We are unsure as to why none of the tagged fish stocked in September were reported. Based on these results we recommend increasing the frequency of stocking events in May and June (to twice a month) if feasible, to ensure an adequate number of fish are available to anglers during peak fishing periods, and re-evaluating whether fish stocked in September are being caught by anglers.

Cape Horn Lake #1

Nampa Fish Hatchery staff stocked 917 catchable Rainbow Trout in Cape Horn Lake #1 in June (n = 300), July (n = 306), and August (n = 311), 2015, and 30 fish (~10%) were tagged during the first and second (June and July) events to estimate return-to-creel on the stocked groups. As of January, 2016, only one tagged fish was reported as harvested (from the July stocking event) and none were reported as caught and released (Table 7). Return-to-creel (use) estimates for each of the two stocked groups, based on tag returns, were 0.0% and 5.9%, respectively (Figure 11). Average return-to-creel across both groups was 3.0% (Figure 12).

Although estimated total use was very low at Cape Horn Lake #1 in 2015, this is the first year we have stocked the lake since 1985, so angler visitation was probably very low. In 2014, staff at McCoy's tackle shop in Stanley brought up concerns to our fisheries staff that stocking was discontinued at one of the more popular put-and-take waters in the Stanley area (F-82 Lake), and felt there should be another similar option available to anglers in the area. To provide another fishery with similar characteristics, we resumed stocking at Cape Horn Lake #1 in 2015. We recommend continuing the current level of stocking and use public outreach (radio, newspaper, local shops, and social media) to encourage angler use at the lake with follow-up surveys to evaluate if effort and catch rates have increased.

Little Bayhorse Lake

Mackay Fish Hatchery staff stocked 2,025 catchable Rainbow Trout in Little Bayhorse Lake in 2015. Approximately 500 fish were stocked during two events in June (6/16 and 6/22) and two events in July (7/1 and 7/19). Fifty fish (~10%) were tagged during each of the four events to estimate return-to-creel on the stocked groups. As of January, 2016, nine fish were reported harvested (one of which was harvested specifically because it was tagged) and two were reported as caught and released (Table 7). Return-to-creel (total use) for each of the stocked groups was estimated at 0.0% for 6/16, 21.4% for 6/22, 10.7% for 7/1, and 7.1% for 7/19 (Figure 11), for an average of 9.8% across all four events (Figure 12).

Estimated total use of fish in Little Bayhorse Lake in 2015 falls slightly below the statewide 2015 average for catchable Rainbow Trout (19.3%), and was much lower than was found for neighboring Big Bayhorse Lake in 2014 (31.8%) (Table 8). Both lakes receive a relatively large amount of angling pressure for the Salmon Region, and return-to-creel rates are good. We are unsure why there were no tags reported from the 6/16 stocking event, especially when estimated use for the 6/22 group (only one week later) was so high. Big Bayhorse Lake likely receives more angling pressure due to better access, especially early in the year. We recommend continuing stocking at the current level but re-evaluating return-to-creel rates on the first stocking event of the year at Little Bayhorse Lake, in the beginning of June, to determine if those fish would be better utilized at an alternative time or location when/where angler use is higher.

Meadow Lake

We tagged 150 Westslope Cutthroat Trout during two days of fyke netting on June 9 and 10, 2015. The fish we were tagging were between 190 mm and 340 mm TL (mean 265 mm TL), and were stocked in the lake as fry in previous years. As of January, 2016, 10 fish were reported as harvested (one of which was harvested specifically because it was tagged), and four were reported as caught and released (Table 9). Total use was estimated at 16.6% and exploitation (harvest) was estimated at 10.7% (Figure 11).

Both, catchable Rainbow Trout and Westslope Cutthroat Trout fry are currently stocked in Meadow Lake every year. In 2014, catchable Rainbow Trout return-to-creel rates were estimated at 49.2% (total use) and 38.0% (exploitation) (Table 8), but return-to-creel rates for Westslope Cutthroat Trout were unknown until now. With relatively high returns for both species, we feel that the current stocking regime at Meadow Lake is successfully sustaining a high quality fishery, in terms of both diversity (multiple species) and high catch rates. Considering the relatively low cost of stocking Westslope Cutthroat Trout as fry, the current stocking regime should be continued.

Mosquito Flat Reservoir

Mackay Fish Hatchery staff stocked 5,653 catchable Rainbow Trout in Mosquito Flat Reservoir in May (n = 1,652), June (n = 1,502), July (n = 1,501), and August (n = 998), 2015, and tagged ~10% of stocked fish from each event to estimate return-to-creel on the stocked groups. As of January, 2016, nine fish were reported as harvested (two from the May group, three from the June group, and four from the July group) and one was reported as caught and released (from the August group) (Table 7). Total use estimates for each stocked group, based on tag returns, was 2.4% for the May group, 3.6% for the June group, 4.8% for the July group, and 1.8% for the August group (Figure 11), for an average of 3.2% throughout the year (Figure 12).

Even though there is excellent access to Mosquito Flat Reservoir, and the area is very popular with campers and other recreationalists (including anglers), return-to-creel rates for all four groups of stocked fish were very poor. There is a great boat ramp and campground at the reservoir, but poor catch rates may be preventing anglers from getting the maximum value out of the fishery. Because trout fisheries are abundant in the Challis area, we want to try to offer a unique opportunity at Mosquito Flat Reservoir to maximize its fishery potential. In 1995, ~4,000 Kokanee Salmon *Onchorhychus nerka* were transplanted to Mosquito Flat Reservoir from Fishhook Creek in the Sawtooth Basin (Liter et al. 2000), but it was unsuccessful at establishing a fishery. During that time, high stocking densities of trout fingerlings (~15,000 to ~30,000 per year) probably resulted in increased forage competition, which may have contributed to the transplant's unsuccessful outcome. However, fingerling stocking was reduced by two-thirds in 2000, and zooplankton quality increased approximately two-fold per year between 2000 and 2002 (Brimmer et al. 2006). We recommend stocking triploid Kokanee Salmon in 2016, and monitor growth and survival to determine if a fishery can be established. A successful Kokanee fishery would be very unique to the Salmon Region, as very little opportunity currently exists in this arena. When polled, local anglers were highly in favor of establishing a Kokanee fishery in Mosquito Flat Reservoir.

Stanley Lake

Nampa Fish Hatchery stocked 8,440 catchable Rainbow Trout in Stanley Lake in 2015 during four stocking events in 2015. Return-to-creel was assessed for only one event (August 17) where both 'magnum' and 'standard' catchables were stocked. Approximately 1,000 of each group was stocked and 10% were tagged for exploitation evaluation from each group (Table 7). As of January, 2016, four tagged fish were reported as harvested from the 'magnum' group and five fish were reported as harvested from the 'standard' group (one was reportedly harvested because it was tagged) (Table 7). Estimated total use was 7.1% for the 'magnum' group and 8.9% for the 'standard' group (Table 7, Figure 11).

Over the previous four years that we have been assessing return-to-creel rates at Stanley Lake, our results have been fairly consistent. June stocking events produce better return-to-creel rates than do stocking events in July and August (Figure 13). Based on these results, more emphasis should be placed on stocking in June, and less in August, to ensure anglers receive the most benefit from catchable stocking in Stanley Lake.

Squaw Creek Pond

Mackay Fish Hatchery staff stocked 663 catchable Rainbow Trout in Squaw Creek Pond in 2015 during one event in May (n = 213) and two events in June (n_1 = 240, n_2 = 210). We tagged 20 fish (~10%) for the group stocked in May and the first group stocked in June, to estimate return-to-creel. As of January, 2016, no fish were reported caught or harvested in Squaw Creek Pond in 2015 (estimated total use = 0.0%).

Squaw Creek Pond is located ~20 miles from the nearest city (Challis) and may not see much angling effort throughout the year. Additionally, low water years with increased temperature may influence survival of fish stocked in Squaw Creek Pond, as there is very little flow entering the pond. We recommend evaluating the current amount of angling effort at the pond in 2016 to determine whether stocking should continue.

MANAGEMENT RECOMMENDATIONS

1. Increase the frequency of stocking events at Blue Mountain Pond in May and June (to twice a month) if feasible, to ensure plenty of fish are available to anglers.

2. Maintain the current level of stocking at Cape Horn Lake #1 and use public outreach (radio, newspaper, local shops, and social media) to encourage angler use at the lake, then re-evaluate return-to-creel rates to determine if the value of the fishery can be increased.

3. Continue stocking at the current level at Little Bayhorse Lake but re-evaluate return-to-creel on the first stocking event of the year, at the beginning of June, to determine if those fish would be better utilized at an alternative time or location when use is higher.

4. Evaluate the potential to establish a Kokanee Salmon fishery in Mosquito Flat Reservoir in 2016, and monitor growth and survival.

5. Evaluate angling effort at Squaw Creek Pond in 2016 to determine whether stocking should continue.

Table 7. Estimated angler exploitation (fish harvested) and total use (fish caught) of catchable Rainbow Trout within 365 days of release in 2015 in selected Salmon Region waterbodies. For Stanley Lake, Magnums are 330 mm (mean TL) Rainbow Trout and Standards are 250 mm (mean TL) Rainbow Trout.

				Disposition			Adjusted exploitation		Adjusted total use	
Water body	Tagging date	Species	Tags released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Blue Mountain Pond	5/8/2015	HRBT	30	5	0	0	29.7%	25.8%	29.7%	25.8%
	6/12/2015	HRBT	30	11	0	0	65.4%	35.2%	65.4%	35.2%
	9/2/2015	HRBT	30	0	0	0	0.0%	n/a	0.0%	n/a
	overall		90	16	0	0	31.7%	16.3%	31.7%	16.3%
Cape Horn Lake #1	6/11/2015	HRBT	30	0	0	0	0.0%	n/a	0.0%	n/a
	7/9/2015	HRBT	30	1	0	0	5.9%	12.1%	5.9%	12.1%
	overall		60	1	0	0	3.0%	6.1%	3.0%	6.1%
Little Bayhorse Lake	6/16/2015	HRBT	50	0	0	0	0.0%	n/a	0.0%	n/a
	6/22/2015	HRBT	50	4	1	1	14.3%	14.4%	21.4%	17.5%
	7/1/2015	HRBT	50	3	0	0	10.7%	12.5%	10.7%	12.5%
	7/19/2015	HRBT	50	1	0	1	3.6%	7.3%	7.1%	10.3%
	overall		200	8	1	2	7.1%	5.3%	9.8%	6.3%
Mosquito Flat Reservoir	5/29/2015	HRBT	150	2	0	0	2.4%	3.5%	2.4%	3.5%
	6/24/2015	HRBT	150	3	0	0	3.6%	4.3%	3.6%	4.3%
	7/16/2015	HRBT	149	4	0	0	4.8%	5.0%	4.8%	5.0%
	8/13/2015	HRBT	100	0	0	1	0.0%	n/a	1.8%	3.7%
	overall		549	9	0	1	2.9%	2.1%	3.2%	2.3%
Squaw Creek Pond	5/20/2015	HRBT	20	0	0	0	0.0%	n/a	0.0%	n/a
	6/15/2015	HRBT	20	0	0	0	0.0%	n/a	0.0%	n/a
	overall		40	0	0	0	0.0%	n/a	0.0%	n/a
Stanley Lake	8/17/2015	Magnums	100	4	0	0	7.1%	7.4%	7.1%	7.4%
		Standards	100	4	1	0	7.1%	7.4%	8.9%	8.2%

Table 8. Estimated mean exploitation (Expl.) (fish harvested) and total use (fish caught) for stocked catchable Rainbow Trout in Salmon Region water bodies 2011 through 2014.

	2011		2012		2013		2014	
Water body	Expl.	Use	Expl.	Use	Expl.	Use	Expl.	Use
Alturas Lake	-	-	-	-	-	-	1.4%	1.4%
Big Bayhorse Lake	-	-	-	-	-	-	25.6%	31.8%
Hayden Pond	-	-	-	-	-	-	20.1%	23.4%
Hyde Pond	-	-	16.9%	46.1%	-	-	0.0%	0.0%
Iron Lake #1	-	-	-	-	-	-	8.3%	11.1%
Iron Lake #2	-	-	-	-	-	-	8.2%	11.0%
Kids Creek Pond	25.5%	47.4%	-	-	19.5%	19.5%	17.2%	17.2%
Meadow Lake	-	-	-	-	-	-	38.0%	49.2%
Mosquito Flats Reservoir	-	-	-	-	33.6%	36.4%	-	-
Salmon River	10.9%	24.3%	15.3%	19.8%	11.5%	15.2%	-	-
Stanley Lake	15.8%	26.2%	14.1%	26.2%	12.0%	15.1%	11.9%	18.9%
Wallace Lake	-	-	-	-	-	-	15.4%	22.3%

Table 9. Estimated exploitation (fish harvested) and total use (fish caught) for Westslope Cutthroat Trout in Meadow Creek Lake in 2015.

			Disposition			Adjusted exploitation		Adjusted total use	
Water body	Tagging date	Tags released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Meadow Creek Lake	6/9/2015	150	9	1	4	10.7%	7.5%	16.6%	9.4%

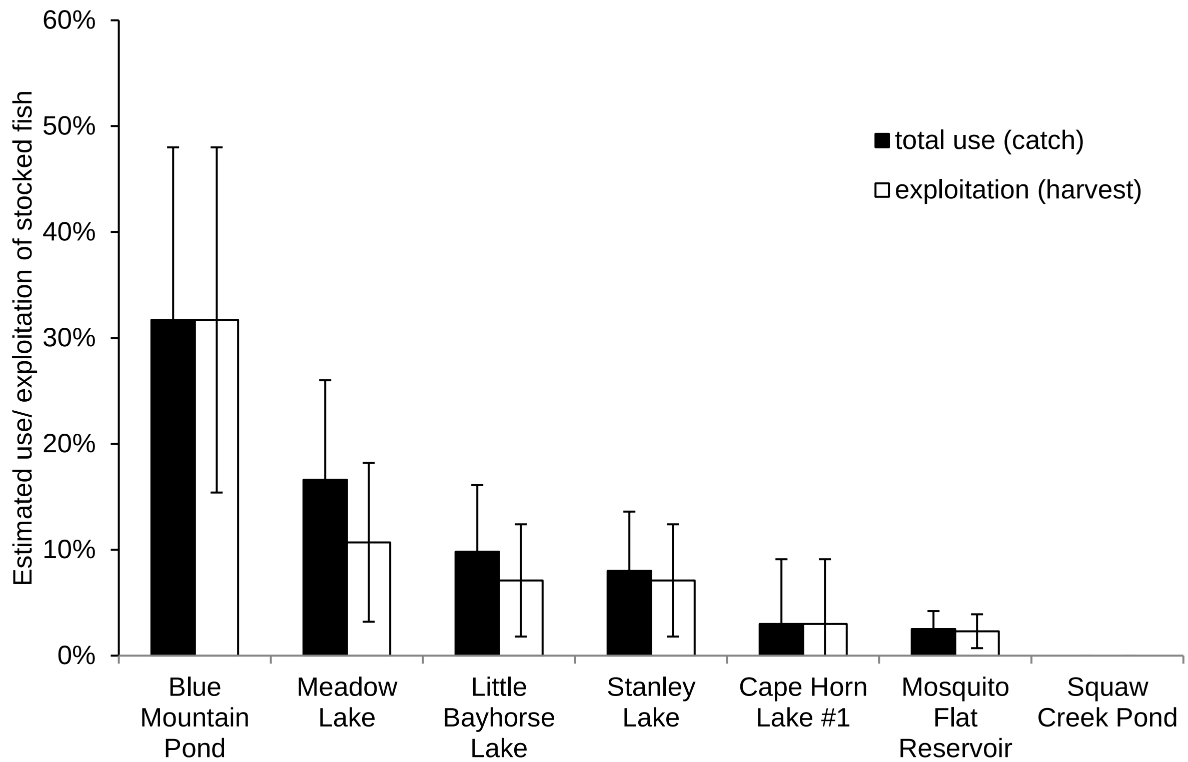

Figure 11. Overall estimated total use (catch) and exploitation (harvest) of catchable Rainbow Trout in six selected waterbodies, and Cutthroat Trout in Meadow Lake, in the Salmon Region, 2015.

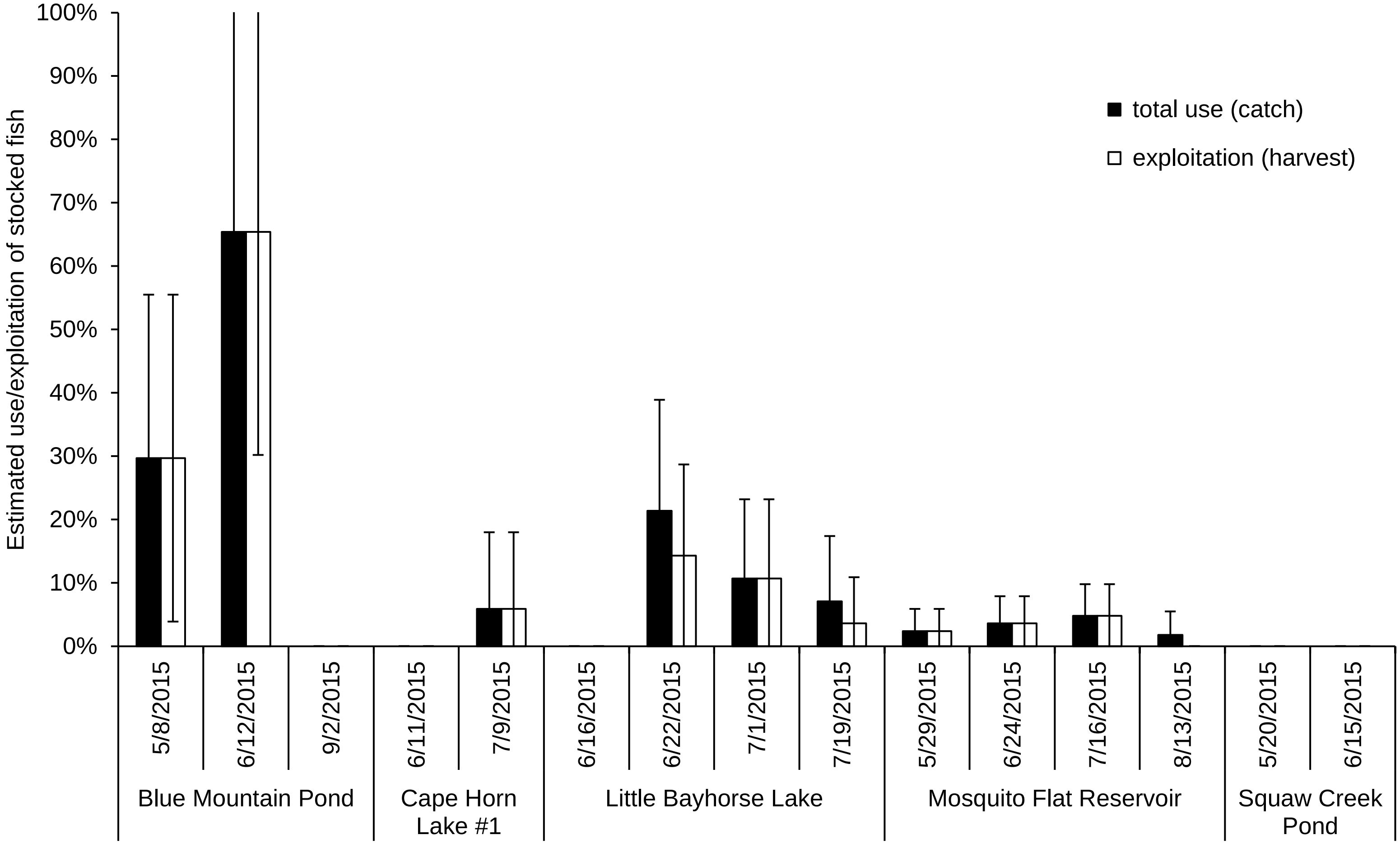

Figure 12. Estimated total use (fish caught) and exploitation (fish harvested) based on angler tag returns for catchable-sized hatchery Rainbow Trout stocked in the Salmon Region in 2015.

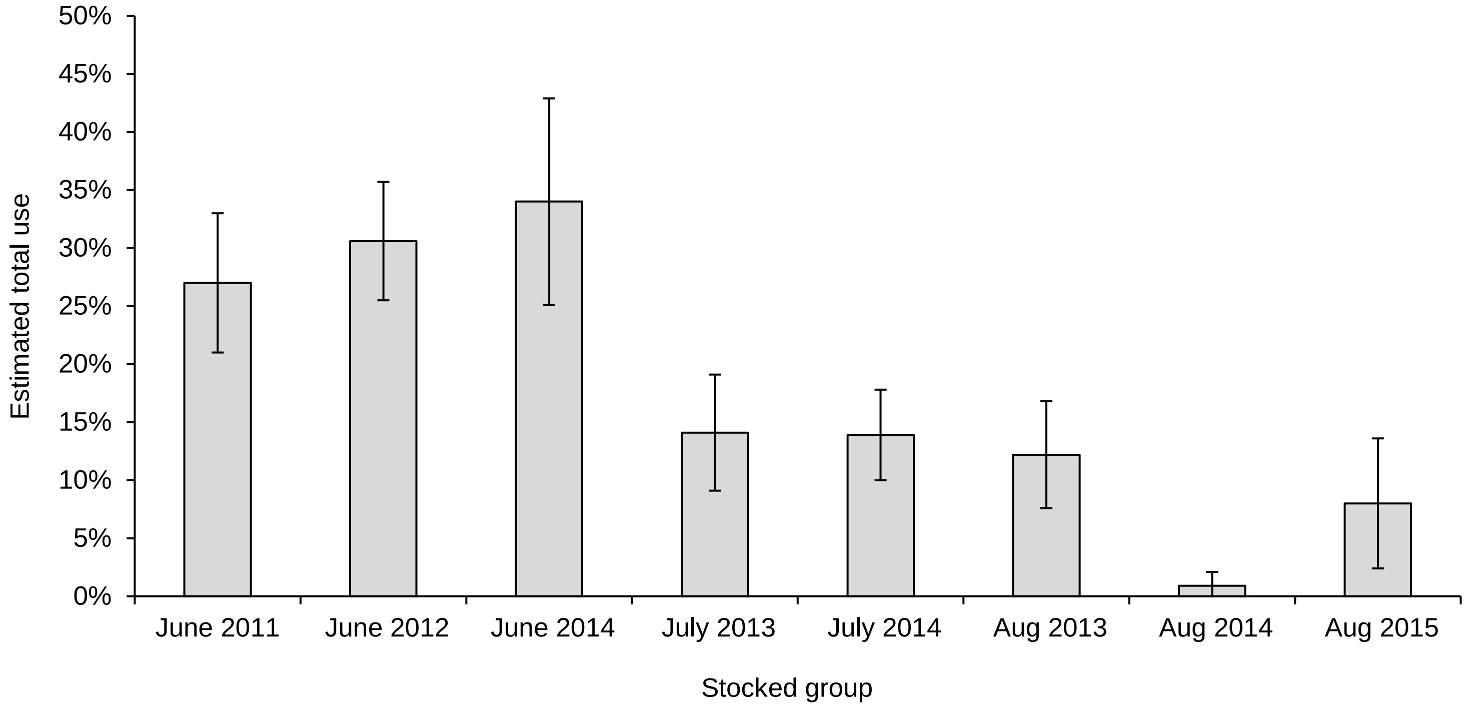

Figure 13. Return-to-creel rates (estimated total use) of catchable-sized hatchery Rainbow Trout by month and year at Stanley Lake, 2011 to 2015, showing a decreasing trend for return-to-creel with groups of fish stocked later in summer.

LOWLAND LAKES AND RESERVOIRS:

WALLACE LAKE REDSIDE SHINER SAMPLING AND TIGER TROUT INTRODUCTION

ABSTRACT

In June, 2015 we stocked 1,795 catchable tiger trout *Salmo trutta x Salvelinus fontinalis* in Wallace Lake as a biological control to reduce Redside Shiner *Richardsonius balteatus* abundance and thereby increase zooplankton quality and abundance. The ultimate goal of reducing Redside Shiner density is to increase forage available for trout, and thereby improve trout growth and size structure. We tagged approximately 10% of the stocked tiger trout (n =178) to evaluate return-to-creel rates and estimated 20.5% use (fish caught) and 13.3% exploitation (fish harvested) on those fish. Angler effort during the 2015 ice-free fishing season (early June through late October) was estimated at 608 hours, based on results obtained from remote trail cameras.

We sampled the Redside Shiner population and zooplankton community in 2015 to evaluate changes in response to the introduction of tiger trout. Size structure of the Redside Shiner population did not appear to change from September 2014 to September 2015, but catch-per-unit-effort decreased significantly from an average of 3.3 fish/minute in 2014 to 1.2 fish/minute (paired t-test, $p = 0.001$). We also noticed a change in Redside Shiner behavior in 2015, where they were more commonly observed hiding amongst large substrate and vegetation, than in open water as seen in 2014. Zooplankton size distribution did not change from 2014 to 2015, but we did observe an increase in total zooplankton biomass, from 0.70 grams/liter in August 2014 to 1.23 grams/liter in August 2015.

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INTRODUCTION

Wallace Lake is a popular put-and-take trout fishery in the Salmon Region that was first stocked with Rainbow Trout *Oncorhynchus mykiss* in 1968. In 1978, Wallace Lake was classified as having low natural spawning potential for trout (Jeppson and Ball 1979), and has since been stocked with approximately 1,000 to 2,000 Rainbow Trout or Cutthroat Trout *Oncorhynchus clarkii,* annually, to sustain the fishery.

In the early 2000's, Redside Shiners *Richardsonius balteatus* were first detected in Wallace Lake (Esselman et al. 2007). The source of Redside Shiner colonization is unknown (ie. introduction or immigration), but over the last 15 years Redside Shiners have become the dominant fish species in the lake, and made up 92% of the catch composition during gill net sampling in June, 2005. Redside Shiners in the lake presumably compete with stocked Rainbow Trout for forage resources (Messner et al. 2015). Zooplankton abundance was so low by 2013 that biologists proposed to introduce tiger trout *Salmo trutta x Salvelinus fontinalis* to reduce Redside Shiner abundance, and increase zooplankton quality and availability for stocked Rainbow and Cutthroat Trout. To ensure stocked tiger trout would be large enough to prey upon Redside Shiners in the lake, they were raised to catchable size (200 to 370 mm TL) and stocked in the spring of 2015. Mackay Fish Hatchery staff stocked 1,795 tiger trout in Wallace Lake during two stocking events in June, 2015.

To quantify the effects of Tiger Trout introduction on the Redside Shiner population in Wallace Lake, and on zooplankton quality and abundance, we began annual monitoring of those communities in 2013. Continual sampling of both communities will help determine when the lake is again suitable for resuming stocking of catchable Rainbow Trout.

Tiger trout are a new species in Idaho, but have been stocked in lakes in Western Washington (Miller 2010) and Utah (Winters 2014) since the early 2000s, in some cases as a means to reduce abundance of undesirable fish species (Budy et al. 2014), similar to our objectives in Wallace Lake. The first tiger trout introduction in Idaho was in June, 2014 at Jim Moore Pond in the Upper Snake Region, where ~7,500 fingerlings (~75 to 150 mm TL) were stocked. The introduction at Wallace Lake was only the second in the state, and tiger trout were stocked at a much larger size (200 to 370 mm TL). The introduction at Wallace Lake therefore presents a unique opportunity for anglers to catch a new species at a quality size in Idaho.

Due to its close proximity to the town of Salmon and relatively easy access via maintained USFS roads, Wallace Lake receives a fair amount of angling pressure during summer months. A 1988 creel survey at Wallace Lake estimated 2,805 hours of angler effort between June 1 and September 5, with an average catch rate of 0.44 fish/hr (Lukens and Davis 1989). In 2015, we used remote creel cameras and the 'Tag-You're-It' program (Cassinelli 2014) to evaluate current angling effort and return-to-creel rates.

STUDY AREA

Wallace Lake (WGS84 datum: 45.24625ºN, 114.00730ºW) is a 3.0 ha lake located approximately 32 km from the town of Salmon. The lake sits at an elevation of approximately 2,470 meters, and has a maximum depth of approximately 10 meters. This lake has been managed as a put-and-take Rainbow Trout fishery since 1968, and has also received periodic stocking of Cutthroat Trout fry and fingerlings since the mid-1990's. In 2014, we assessed return-to-creel rates on approximately 2,150 stocked catchable Rainbow Trout in the lake, Harvest and total use were 15.4% and 22.3%, respectively (Messner et al. 2016). Although angler use has been fair, we have observed an overall decrease in body condition of stocked Rainbow Trout at the lake since the early 2000's when Redside Shiners were first documented. It is likely that an increasing Redside Shiner population has led to a reduction in forage resources, thereby resulting in the poor condition of stocked Rainbow Trout over the last several years (Messner et al. 2015). In June, 2015, we stocked 1,795 catchable-size (200 to 370 mm TL) tiger trout to try to reduce abundance of Redside Shiners and increase available forage for stocked catchable Rainbow Trout.

METHODS

Biological Sampling

Tiger Trout

Mackay Fish Hatchery staff stocked 1,795 catchable size (200 to 370 mm TL) tiger trout in Wallace Lake during two stocking events in June, 2015 (June 8 and June 18). A subsample (~10%) of tiger trout from each stocking event were weighed (g), measured (mm TL), and tagged with FLOY t-bar anchor tags to estimate return-to-creel rates, using the Tag-You're-It program methodology (Cassinelli 2014). Tiger trout were sampled again on September 28 by deploying one sinking and one floating monofilament gill net (36 m long by 1.8 m deep, and composed of six panels of 10.0, 12.5, 18.5, 25.0, 33.0, and 38.0 mm mesh) for one hour.

We compared body condition for tiger trout at the time of stocking and when they were resampled in September using the relative weight (W_r) index. We first calculated standard weight (W_s) using the equation:

$$Log_{10}(W_s) = a + b * \ Log_{10}(\text{total length (mm)})$$

where a and b were derived from the length-weight relationship for Brown Trout in Blackwell et al. (2000) (*a* = -4.867 and *b* = 2.96, Appendix A). This relationship most closely resembled the length-weight relationship we observed from the tiger trout we stocked in Wallace Lake in 2015 (r^2 = 0.91, a = -4.738 and b = 2.90). Relative weight was then calculated using the equation:

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

In September, we examined tiger trout diets using gut contents from mortalities collected in gill nets (n = 14), and recorded percent (%) fullness and % composition by organism type (i.e. fish parts, macro-invertebrates, plankton, or other).

Redside Shiners

Minnow trapping methods for Redside Shiners in 2015 followed the same methods outlined in the 2014 IDFG Salmon Region Annual Report (Messner et al. 2016). Redside Shiners were trapped using Promar collapsible minnow traps (38 cm L x 24 cm W x 26 cm H, with a 3 cm opening and 2 mm x 4mm mesh size) baited with canned tuna in oil. Traps were deployed on June 5, July 24, and September 18, 2015 to track relative abundance using catch-per-unit-effort (CPUE) and determine the seasonal size structure of the Redside Shiner community.

Nine trap clusters, consisting of three minnow traps each, were uniformly deployed around the lake perimeter and fished for one hour during each of three capture events (Figure

14, Table 10). Trap clusters were set 2-3 meters away from shore at an average depth of 1 m. Redside Shiners were then enumerated by trap for each cluster. Weight (g) and total length (mm) measurements were taken from a subsample of approximately 50 shiners randomly collected from each trap cluster, during each capture event. If fewer than 50 Redside Shiners were captured in a cluster, then all individuals were sampled. Exact fishing start and stop times were recorded to calculate catch-per-unit-effort (fish per minute). This information was then used to compute Redside Shiner relative abundance and size structure for comparison to past and future trapping events. We used a paired t-test ($\alpha = 0.05$) to test for differences in trap cluster relative abundance from September 2014 to September 2015.

Two additional minnow traps were used during the September 2015 trapping event to test if Redside Shiners had redistributed into deeper areas of the lake. The traps were set near the center of the lake at a depth of 3 m and were removed after fishing for 75 minutes. Data gathered from these two traps was not used to assess CPUE changes from 2014.

Zooplankton

Zooplankton sampling was conducted at Wallace Lake at two locations on August 17, 2015. The lake is only 2.7 ha in size and does not have a well-defined inlet, so we only sampled near the outlet and at mid-lake (no sampling near the inlet). We performed three vertical tows, using Wisconsin-style plankton nets with mesh sizes 153µm, 500µm, and 750µm, at each location following methods outlined in Teuscher (1999). Samples were stored in 100% ethyl alcohol for thirteen days, at which time contents were weighed and zooplankton ratio index (ZPR) and zooplankton quality index (ZQI) were calculated using the methods outlined in Teuscher (1999). ZQI and ZPR values less than 0.60 indicate competition for forage is likely occurring.

<u>Angler Effort and Return-to-Creel</u>

From June 8 to October 26, 2015 we conducted a remote creel survey at Wallace Lake. We positioned three trail cameras to photograph the entire lake (Figure 15), All three cameras were set to take photos at the same time (every hour, on the hour) each day, from 0700 to 2100 hours. We downloaded photos once a month and stored them at the regional office. To estimate daily angler effort, we enumerated anglers in each photo and referenced between cameras to make sure no anglers were enumerated twice during any given hour. We then summed the total number of unique anglers observed per hour each day from the three cameras to determine the total daily angler effort. Daily counts were summed for each month to arrive at monthly angler effort estimates.

Return-to-creel rates (exploitation and use) were estimated using the methods outlined in chapter two of this report (Chapter Two: Exploitation Studies) (Cassinelli et al. 2104). Mackay Fish Hatchery staff stocked 1,795 catchable Tiger Trout in Wallace Lake during two stocking events in June (June 8, n = 772, June 18, n = 1,023). Approximately 10% of the stocked fish (n = 178) were tagged to estimate return-to-creel. Detailed methods and calculations can be found in Meyer et al. (2010).

RESULTS AND DISCUSSION

Biological Sampling

At the time of stocking on June 8, 2015, tiger trout ranged in TL from 181 to 390 mm TL (n = 78, mean 282.6 mm). Tiger trout stocked on June 18 ranged in TL from 202 to 370 mm (n = 100, mean 287.9 mm TL) (Figure 16). Mean W_r values for June 8 and June 18 stocking were 97.8 and 91.4, respectively (Figure 17). The tiger trout were very healthy and active upon stocking, and we observed them chasing and feeding on groups of Redside Shiners immediately. However, when we re-sampled tiger trout on September 28, 2015, W_r values were much lower than we observed at the time of stocking (Figure 17). We captured 30 tiger trout in two combined hours of gill netting (CPUE = 15 fish/hr) ranging in TL from 237 to 382 mm (mean 310.73 mm TL) (Figure 16), with a mean W_r of 78.5 (Figure 17). In addition to poor body condition in September, examination of tiger trout stomachs showed 13 of 14 stomachs were only 5% full, and were composed of 100% invertebrate parts (combination of macroinvertebrates and zooplankton). One tiger trout stomach was 75% full with what appeared to be mammalian hair, but no bones were found. These results suggest that tiger trout were not, at that time, consuming Redside Shiners.

Redside Shiners were trapped on three occasions in 2015. We caught 1,670 Redside Shiners in June, 3,107 Redside Shiners in July, and 666 Redside Shiners in September. Overall CPUE was 3.0 fish/minute in June, 5.7 fish/minute in July, and 1.2 fish/minute in September (Table 11). Mean CPUE for all nine trap clusters decreased significantly from September 2014 to September 2015 (Table 12) (paired t-test, df = 8, $p = 0.001$). During each capture event, a subsample of Redside Shiners was measured and weighed (June = 455, July = 450, September = 471). Mean length and condition factor (K ± SE) of subsampled Redside Shiners was similar for all three months sampled. Mean TL (± SE) was 95 mm (± 0.75) in June, 94 mm (± 0.84) in July, and 91 mm (± 1.09) in September (Table 11, Figure 18), and condition factor (K) was 0.82 (± 0.01) for all three months (Table 11). The two traps set near the center of Wallace Lake in September captured one Redside Shiner with 150 minutes of total fishing effort, suggesting Redside Shiners were not distributed throughout the pelagic zone. These two additional traps were not used to assess CPUE or size structure.

Compared to September, 2014, very few Redside Shiners were observed in the littoral area of the lake prior to deploying traps in September, 2015. This observation was corroborated by the fact that Redside Shiner CPUE had significantly decreased from September 2014 to September 2015. Although it appears that Redside Shiners were less abundant in 2015, a change in behavior with preference toward areas of high cover to avoid predation may have also influenced our findings. After baited traps were deployed, Redside Shiners began emerging from high cover areas, but still appeared to be in lower abundance than what was observed during previous surveys. Additionally, the turbidity of the water had increased in September 2015, and the water had a green hue that was not observed during previous trapping events. Increased turbidity and color may have been a result of increased phytoplankton and/or zooplankton abundance in the lake, due to a reduction in Redside Shiner foraging.

Zooplankton sampling on August 17, 2015 found mean ZPR = 0.0, mean ZQI = 0.0, and mean total biomass = 1.23 g/m^3 (Table 13). Although ZPR and ZQI values have not increased over the last three years at Wallace Lake, we have observed an increase in total zooplankton biomass, suggesting small bodied zooplankton are becoming more abundant (Figure 19). This may have contributed to the increased color and turbidity we observed. Since tiger trout sometimes do not switch to piscivory until they reach a larger size (~340mm TL) (Winters 2014), they may still have been consuming zooplankton in Wallace Lake 2015, and had not switched over to a piscivorous diet. However, decreased Redside Shiner CPUE in minnow traps and observation of tiger trout actively chasing Redside Shiners in June suggest some interaction between the two species, although it may be somewhat minimal at this point in time. If tiger trout are successful at reducing Redside Shiner abundance over the next year or so, we anticipate observing an overall increase in the quality and abundance of zooplankton (ZPR and ZQI) in the lake during future August sampling events.

Angler Effort and Return-to-Creel

Estimated angler effort at Wallace Lake from June 8 to October 26, 2015 was 608 hours (Table 14). Angling effort was highest from July through September, with a peak in July (Table 14, Figure 20). Despite excellent boating access at the lake, bank anglers were encountered almost twice as often as boat anglers (Table 14, Figure 21). Although estimated effort in 2015 is approximately 78% lower than was estimated in 1988 (estimated 2,805 hours fished between June 1 and September 5), comparing these two values may not be valid. The 1988 survey was an expanded estimate, generated from only four or five days of sampling per month, and favored weekend sampling which likely overestimated angling effort for the entire period. In 2015, we found angler effort was, on average, 41% higher on weekend days versus weekdays (6.1 hours per day versus 3.6 hours per day, respectively) (Table 15). Angler effort was highest between 1200 and 1900 hours (Figure 22), so instantaneous counts conducted during those periods, and expanded, would also likely overestimate overall effort. The 2015 angler effort results should therefore serve as a baseline for future studies conducted using this same methodology. We intend to monitor angler effort over the next few years to determine how the development of this unique fishery plays a role on angler dynamics at Wallace Lake.

Of 178 tagged tiger trout, 17 were reported as harvested (four from the June 8 event and 13 from the June 18 event). Two from each event were harvested specifically because they were tagged, and three were reported as caught and released (two from the June 8 event and one from the June 18 event) (Table 16). Total use for each stocked group was 14.1% and 25.5%, respectively, for an overall average of 20.5% total use across both groups. Only 13.3% of the total number of stocked tiger trout were estimated to be harvested (Table 16). Overall, anglers that caught tiger trout at Wallace Lake in 2015 were pleased with the opportunity to catch a new and different species of fish (information obtained from angler comments, J. Cassinelli, IDFG, personal communication). Return-to-creel rates suggest these fish are readily available to anglers, but that anglers are not inclined to keep all tiger trout caught. This is especially important considering tiger trout were introduced in the lake in order to reduce Redside Shiner abundance through predation, and harvest may have inhibited our ability to detect any biological response to the introduction.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring Redside Shiner abundance, size structure, and condition as they relate to the effects of tiger trout introduction.

2. Continue annual monitoring of zooplankton quality and abundance to determine the primary forage-base response to tiger trout introduction.

3. Stock additional tiger trout in 2016 and evaluate exploitation and use of these fish to guide future stocking needs.

4. Evaluate angler effort in 2016 to determine the influence of establishing this unique fishery on angler dynamics at the lake.

Table 10. Minnow trap cluster locations (WGS84) (±3m) used for Wallace Lake Redside Shiner monitoring.

	Location (WGS84)	
Cluster No.	Latitude °N	Longitude °W
1	45.24627498	-114.00484100
2	45.24596804	-114.00467399
3	45.24570501	-114.00516098
4	45.24545900	-114.00614603
5	45.24542397	-114.00746903
6	45.24593703	-114.00725797
7	45.24650901	-114.00701104
8	45.24698996	-114.00608903
9	45.24695601	-114.00522301

Table 11. Summary statistics from Wallace Lake sampling, 2005-2015, including Redside Shiner sub-sample size (*n*), relative abundance (CPUE), total length statistics (mm), and condition factor (K).

			Total length (mm)			Condition factor (K)		
	n	CPUE (fish/min)	Min	Max	Mean (SE)[b]	Min	Max	Mean (SE)
Jun 2005[a]	76	0.02	90	156	113 (2.09)	1.10	2.14	1.45 (0.02)
Aug 2013	101	1.12	57	141	86 (1.21)	0.50	1.08	0.77 (0.01)
Jun 2014	480	2.70	73	156	93 (0.48)	0.41	1.59	0.88 (0.01)
Aug 2014	178	0.74	41	140	83 (1.10)	0.35	1.46	0.82 (0.01)
Sep 2014	457	3.30	45	149	89 (0.75)	0.44	1.32	0.86 (0.00)
Jun 2015	455	3.01	57	147	95 (0.75)	0.40	1.16	0.82 (0.00)
Jul 2015	450	5.74	53	156	94 (0.84)	0.45	2.10	0.82 (0.01)
Sep 2015	371	1.22	42	156	91 (1.09)	0.26	1.47	0.82 (0.01)

[a] Shiners were collected during gill netting in 2005, and minnow traps all other years.
[b] Standard errors (SE) were reported incorrectly in 2014 management report (Messner et al., *in press* [b]).

Table 12. Redside Shiner catch-per-unit-effort (CPUE) at all nine trap clusters, September 2014 and 2015.

		Trap cluster									
	Year	1	2	3	4	5	6	7	8	9	Total
CPUE (RSS/min)	2014	6.00	4.40	2.00	2.10	2.00	1.10	3.50	4.10	4.70	3.30
	2015	3.70	0.40	0.03	0.03	1.85	0.80	0.56	0.18	3.42	1.22

Table 13. Zooplankton total biomass, ZPR, and ZQI average values obtained from mid-august sampling, 2013-2015.

Survey Year	2013	2014	2015
Mean total biomass (g/l)	0.48	0.70	1.23
Mean zooplankton Ratio (ZPR)	0.33	0.00	0.00
Mean zooplankton quality index (ZQI)	0.01	0.00	0.00

Table 14. Angler use at Wallace Lake from June 8 to October 26, 2015. Values were estimated using three remote trail cameras positioned around the lake, which captured hourly photos of anglers fishing.

	June	July	August	September	October	Total
Anglers (#)	64	137	90	67	52	410
Angler hours	87	195	122	126	78	608
Boat anglers (#)	19	54	35	28	10	146
Boat hours	26	77	47	53	16	219
Bank anglers (#)	45	83	55	39	42	264
Bank hours	61	118	75	73	62	389

Table 15. Angler effort at Wallace Lake by day-type (weekday vs. weekend day) from June 8 to October 26, 2015. Mean hours per day was calculated by dividing angler effort (hours) by the number of days surveyed.

	June		July		August		September		October		Total	
	Week	Weekend	Week	Weekend	Week	Weekend	Week	Weekend	Week	Weekend	Week	Weekend
Days surveyed (#)	17	6	23	8	21	10	22	8	18	8	101	40
Angler effort (hours)	53	34	139	56	63	59	63	63	46	32	364	244
Mean hours/ day	3.1	5.7	6.0	7.0	3.0	5.9	2.9	7.9	2.6	4.0	3.6	6.1

Table 16. Estimated exploitation (fish harvested) and use (fish caught) for tiger trout stocked in Wallace Lake in 2015.

			Disposition			Adjusted exploitation		Adjusted total use	
Water body	Tagging date	Tags released	Harvested	Harvested b/c tagged	Released	Estimate	90% C.I.	Estimate	90% C.I.
Wallace Lake	6/8/2015	76	2	2	2	4.7%	6.8%	14.1%	11.7%
	6/18/2015	98	11	2	1	20.0%	12.5%	25.5%	14.1%
	Overall	174	13	4	3	13.3%	7.9%	20.5%	9.9%

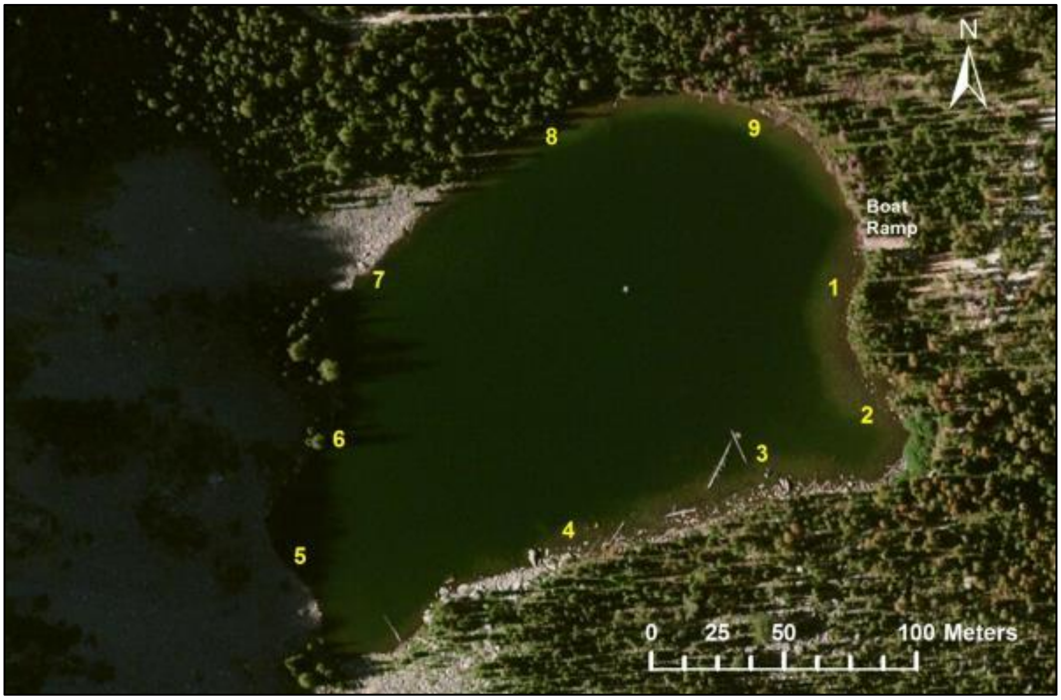

Figure 14. Locations (±3.0m) of minnow trap clusters and boat ramp shore access used for Wallace Lake Redside Shiner trapping on 9/11/2015. Specific coordinates are displayed in Table 10.

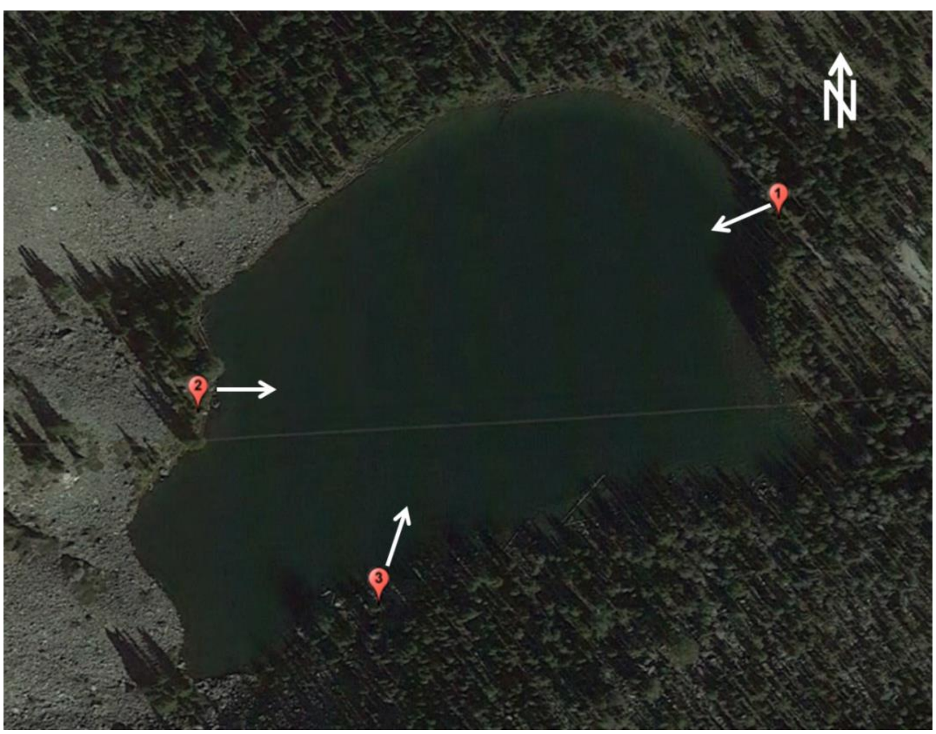

Figure 15. Camera locations and directions of view for estimating angler effort from June 8 to October 26, 2015 at Wallace Lake.

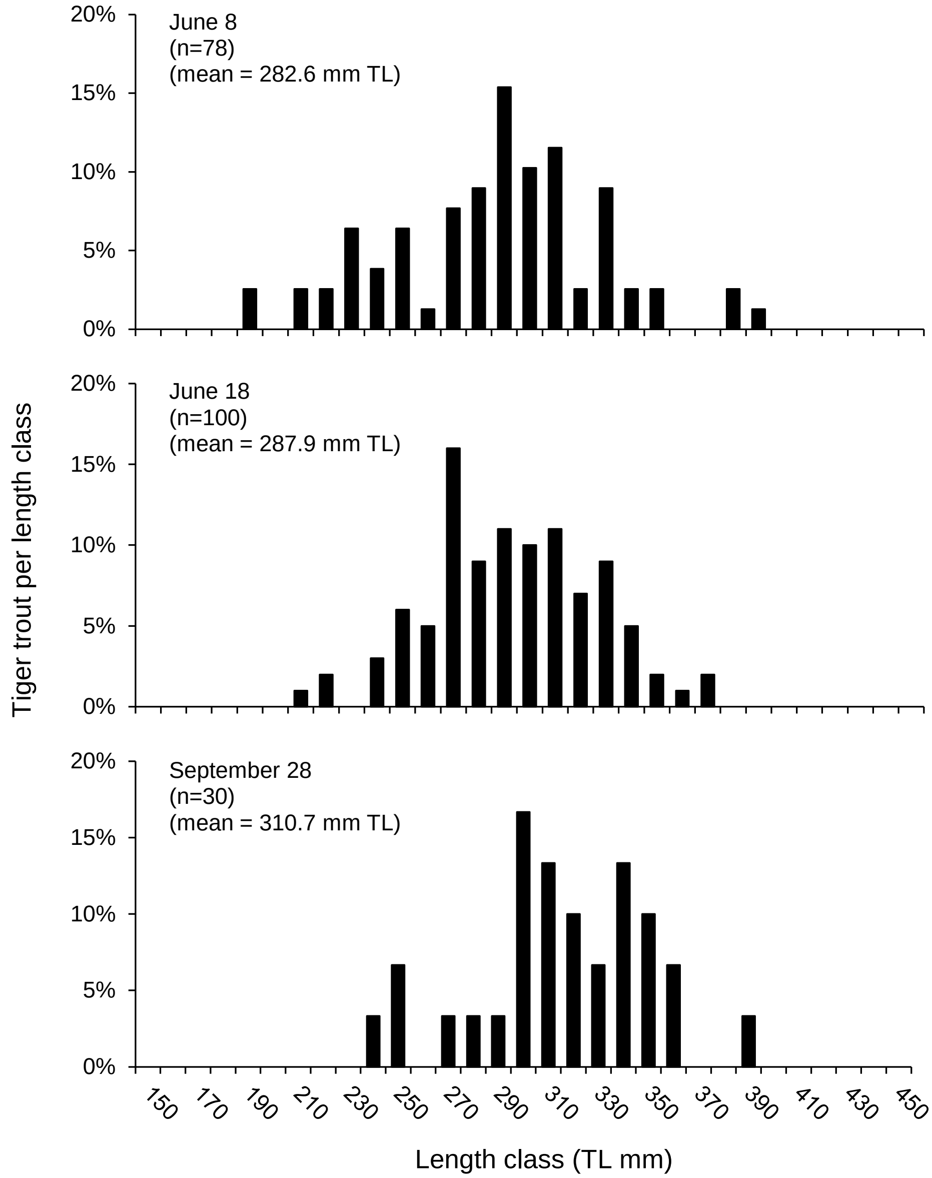

Figure 16. Length-frequency distribution of tiger trout subsampled from the two June stocking events and September gillnetting at Wallace Lake in 2015.

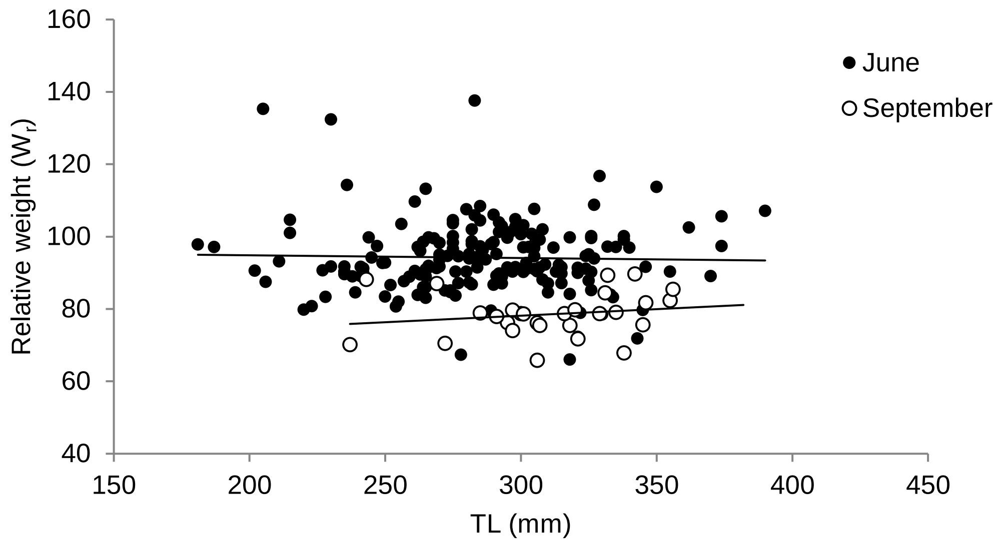

Figure 17. Relative weight (W_r) for all measured tiger trout in 2015, showing decrease from June to September.

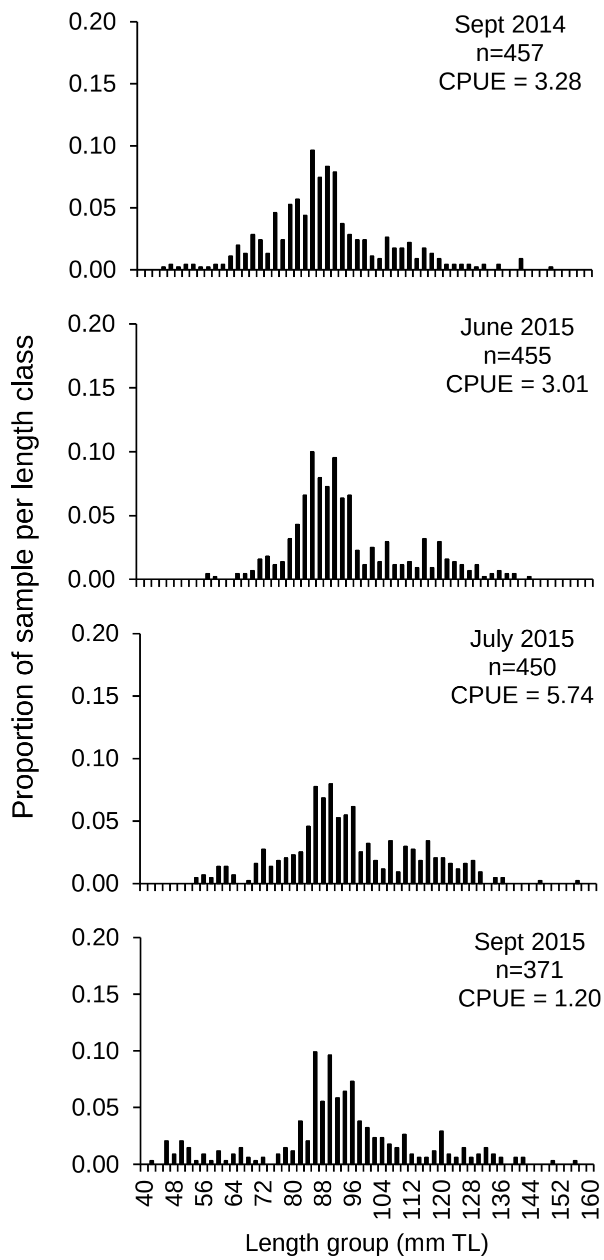

Figure 18. Size structure of the Redside Shiner population in Wallace Lake during sampling efforts from September, 2014 to September, 2015. Catch-per-unit-effort (CPUE) = number of fish caught per minute of sampling.

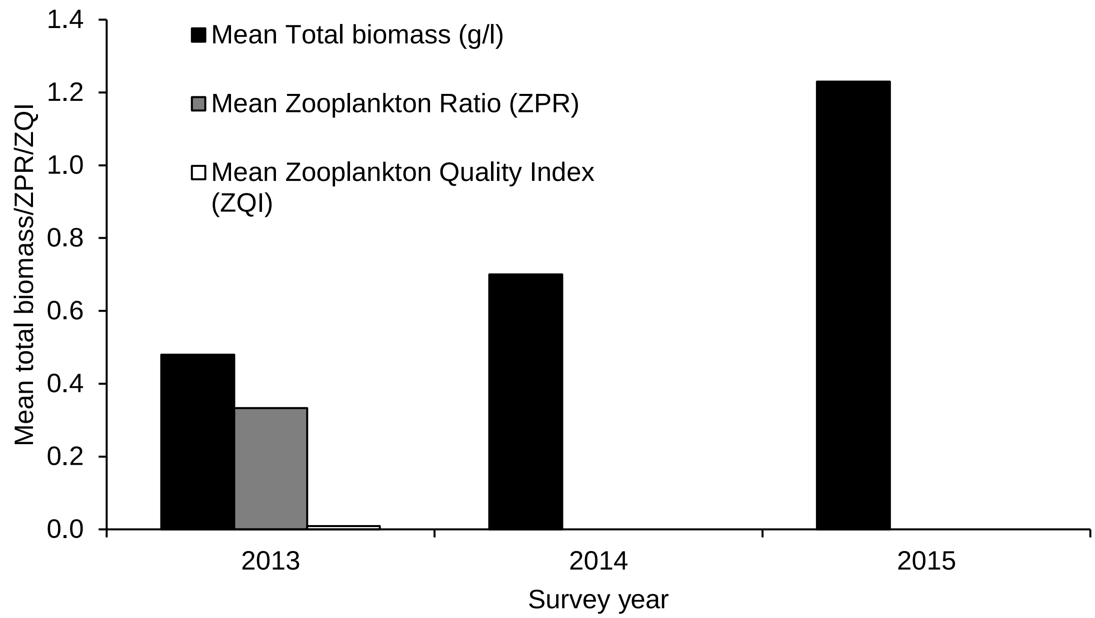

Figure 19. Zooplankton quality and abundance values from Wallace Lake in mid-August, 2013-2015.

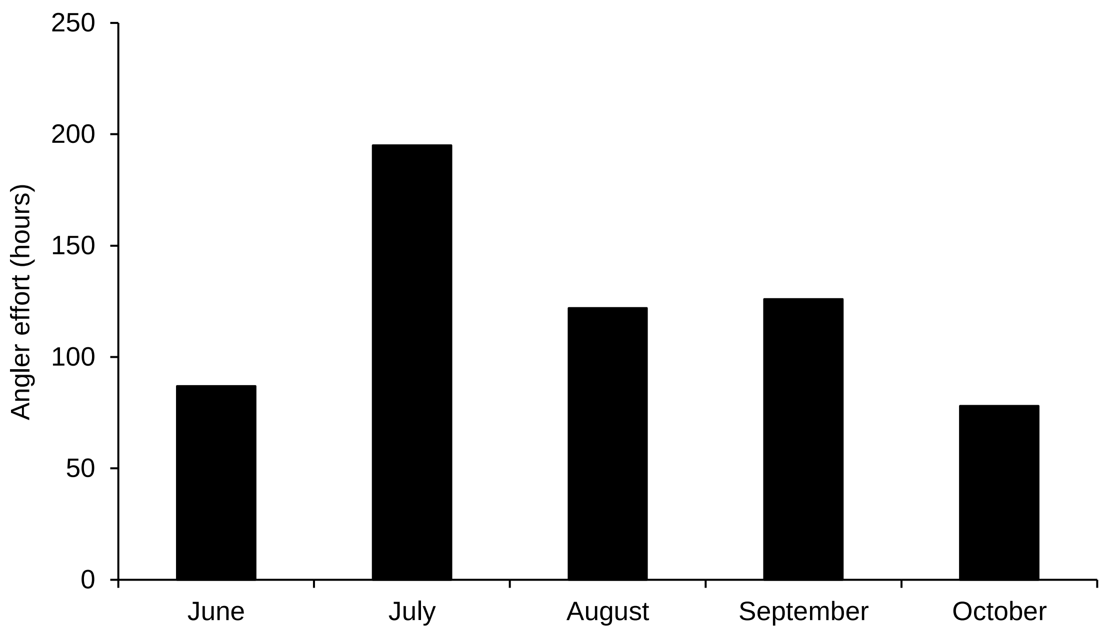

Figure 20. Monthly angler effort at Wallace Lake, June 8 through October 26, 2015.

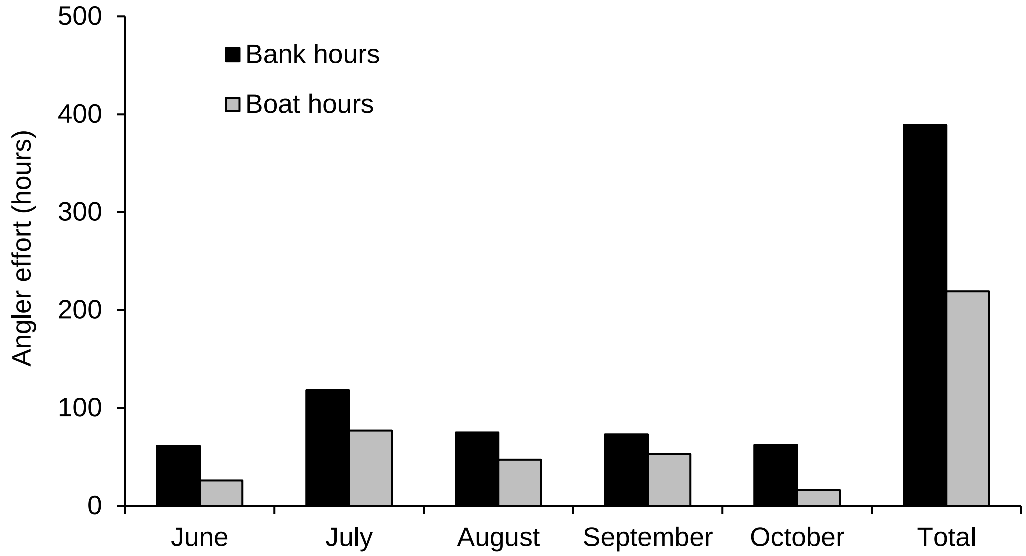

Figure 21. Monthly angler effort by type (boat or bank) at Wallace Lake, June 8 through October 26, 2015.

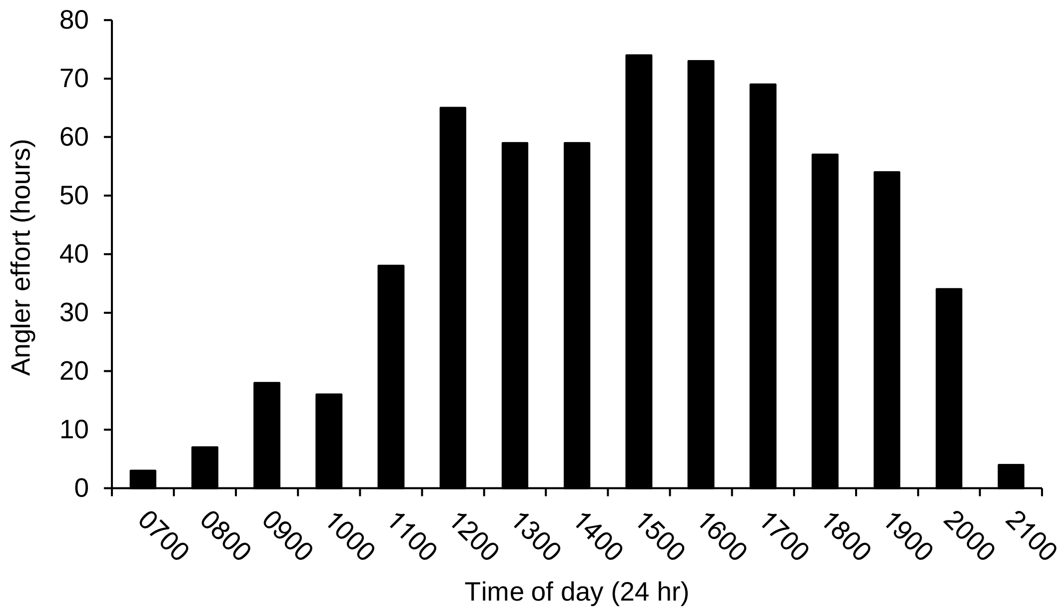

Figure 22. Angler effort by time of day at Wallace Lake from June 8 to October 26, 2015.

LOWLAND LAKES AND RESERVOIRS:

INVENTORIES - FISH AND ZOOPLANKTON

ABSTRACT

In 2015, we sampled the fish and/or zooplankton communities in six lakes in the region to fulfill various objectives. We found multiple species and size classes of trout present in Mosquito Flat Reservoir in early May 2015, before stocking had begun for the year, suggesting fish overwinter to provide opportunity for anglers in the early spring.

In Stanley Lake, we captured six Lake Trout *Salvelinus namaycush* in the end of May, to determine what parts of the lake they inhabit after ice-off and before stratification. We found Lake Trout at a depth of approximately 20 to 30 m, approximately 10 to 20 m offshore, and mainly around the east shore of the lake.

We set two gill nets in Yearian Reservoir in April, 2015 to determine the composition, relative abundance, and size structure of the fish community. Several size classes of naturally reproducing Rainbow Trout *Oncorhynchus mykiss* were sampled, ranging in size from 172 to 375 mm TL, in relatively high abundance (CPUE = 3.18 fish/hr).

We sampled Yellowbelly Lake to evaluate the effectiveness of increased Westslope Cutthroat Trout *Oncorhynchus clarkii* fingerling stocking over the last several years. No Westslope Cutthroat Trout were collected during gill netting and, similar to other survey years, the lake was primarily dominated by Northern Pikeminnow *Ptychocheilus oregonensis* and Largescale Suckers *Catastomus macrocheilus*.

Zooplankton quality and abundance increased in both Mosquito Flat Reservoir and Williams Lake from recent years. Zooplankton quality and abundance in both Herd Lake and Yellowbelly Lake were very low in 2015.

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INTRODUCTION

The Salmon Region defines lowland lakes as being generally accessible by road and able to be stocked with fish by truck. There are 23 lowland lakes, two reservoirs, and 11 public ponds in the Salmon Region (Curet et al. 2011). Fisheries management objectives for lowland lakes in the Salmon Region focus on providing diverse angling opportunities (i.e. species diversity), with catch rates above 1 fish/hr, and diverse size structure. Understanding fish composition, relative abundance, and size structure is an important part of managing these fisheries, and helps us prioritize management efforts where they are most likely to provide benefit to anglers.

OBJECTIVES

1. Determine the species composition, relative abundance, and size structure of fish in Mosquito Flat Reservoir, prior to stocking catchable Rainbow Trout *Oncorhychus mykiss* in the spring.

2. Determine gill netting locations and depths most effective for targeting Lake Trout *Salvelinus namaycush* in the spring at Stanley Lake.

3. Gather baseline fish population information, including abundance and size structure, for Yearian Reservoir (privately owned/ public access) to evaluate its potential as a fishery.

4. Sample Yellowbelly Lake to determine whether Westslope Cutthroat Trout *Oncorhynchus clarkii* have become established as a result of increased stocking efforts over the last 3 years.

5. Quantify zooplankton quality and abundance in Mosquito Flat Reservoir, Yellowbelly Lake, Williams Lake, and Herd Lake to determine forage availability for fish.

STUDY AREAS AND METHODS

Mosquito Flat Reservoir

Mosquito Flat Reservoir (WGS84 datum: 44.51902° N, -114.43566° W) is located on Challis Creek, approximately 20 km from the town of Challis. It is 16.2 ha in size and sits at 2,114 m in elevation. The reservoir dam was constructed in 1954, and at full pool stores 986,784 m^3 (800 acre feet) of water. In 1984, 28% of the reservoir's volume was donated to IDFG for fisheries management (Liter and Lukens 1994), and in 2012 IDFG provided funding to help make needed structural improvements to the dam. IDFG began stocking the reservoir in 1968, and has been stocking approximately 4,500 to 6,000 catchable-sized Rainbow Trout per year since 2000. The reservoir is a popular local fishery due to its proximity to the city of Challis, and the Salmon-Challis National Forest (SCNF) maintains an 11-site campground and day-use picnic area along the reservoir's east-southeast shore.

We set two pairs of standard lowland lake gill nets (one sinking and one floating, per pair) (46 m x 2 m, with six panels consisting of 19, 25, 32, 38, 51, and 64 mm bar mesh) overnight in Mosquito Flat Reservoir on the evening of May 13, 2015 to determine the species composition, relative abundance, and size structure of the fish population before stocking had begun for the year. Fish caught in the gill nets were identified to species, enumerated, measured (mm TL), and weighed (g). Relative abundance (catch-per-unit-effort, CPUE) was calculated as the total number of fish caught, divided by the total number of gill net hours. Relative weight (W_r) was calculated by first calculating standard weight (W_s) using the equation:

$$Log_{10}(W_s) = a + b * \ Log_{10}(\text{total length (mm)})$$

where *a* = the intercept value and *b* = slope derived from Blackwell et al. (2000) (Appendix A). The log value is then converted back to base 10, and relative weight is then calculated using the equation:

$$W_r = \left(\frac{\text{weight (g)}}{W_s}\right) * 100$$

Zooplankton samples were collected at Mosquito Flat Reservoir on August 18, 2015. Tows were conducted near the inlet, mid-lake, and at the outlet following methods outlined by Teuscher (1999). Tows were conducted from a depth of 3.0 m near the inlet, and 7.7 m at mid lake and near the outlet. Samples were stored in 100% ethyl alcohol for eleven days, at which time they were analyzed using methodology presented in Teuscher (1999). Total zooplankton biomass (grams/liter) at each site is quantified by weighing the dried contents of the 153 µm net and dividing by tow depth. The zooplankton ratio index (ZPR) is the ratio of preferred to useable zooplankton, and is calculated by dividing the dried weight of the 750 µm sample (preferred) by the dried weight of the 500 µm sample (useable). The zooplankton quality index (ZQI) is the index of overall abundance and size ratios, and is calculated by dividing the sum of weights for the 500 µm and 750 µm samples by ZPR. Average total biomass, ZPR, and ZQI are calculated for each lake by averaging across the three sampling locations at each lake.

Stanley Lake

Stanley Lake (WGS84 datum: 44.24371ºN, 115.05653ºW) is located in the Sawtooth Basin, near Stanley, Idaho. Stanley Lake is 71.3 ha in size and sits at 1,990 m in elevation. IDFG first stocked the lake in the 1940's, and has been stocking hatchery catchable Rainbow Trout since 1956 (IDFG stocking website). We stocked ~14,000 catchable Rainbow Trout in Stanley Lake in 2014 and ~7,000 in 2015. The Sawtooth Basin is a popular destination for tourists during summer months, so the lake is managed as a put-and-take opportunity for visiting anglers. In addition to stocked Rainbow Trout, there are naturally reproducing populations of Kokanee Salmon *Oncorhynchus nerka*, Brook Trout *Salvelinus fontinalis*, Westslope Cutthroat Trout, Bull Trout *Salvelinus confluentus*, Lake Trout and Redside Shiners *Richardsonius balteatus* in Stanley Lake. Trout limit is six per person per day, with the exception of Brook Trout (25 per day) and Bull Trout (0 per day, catch-and-release only).

We set two pairs of standard lowland lake gill nets (one sinking and one floating, per pair) (46 m x 2 m, with six panels consisting of 19, 25, 32, 38, 51, and 64 mm bar mesh) at Stanley Lake on May 20-22, 2015 to determine where Lake Trout can be effectively sampled during the spring. Increased interest has developed over the last few years in the region to understand the dynamics of the Lake Trout population in Stanley Lake, and ensure the persistence of this unique fishery does not have negative impacts on native fish restoration efforts in the area (i.e. Sockeye Salmon *Oncorhynchus nerka* recovery). Lake depths were recorded for each net and approximate depths and locations for all Lake Trout caught were recorded. All four gill nets were first set for approximately two to three hours in the evening, then moved and set for ~three to six hours the following day, then moved again and set overnight for approximately 17 hours, each. Fish caught in the gill nets were identified to species, enumerated, measured (mm TL), and weighed (g). Relative abundance (catch-per-unit-effort: CPUE) was calculated as the total number of fish caught, divided by the total number of gill net hours. Relative weight (W_r) was calculated using the same methods outlined above.

We conducted a temperature and oxygen profile at the lake on May 21, 2015 at Stanley Lake to determine if the lake had stratified yet. Profiles were conducted in the middle of the lake using a YSI 556MPS multi-meter probe with a 20m sensor cord.

Zooplankton samples were collected at Stanley Lake on August 20, 2015. Tows were conducted near the inlet, mid-lake, and at the outlet following methods outlined by Teuscher (1999). Tows were conducted from a depth of 9.1 m at all three locations. Samples were stored and analyzed using the methods outlined above.

Yearian Reservoir

Yearian Reservoir (WGS84 datum: 44.88716ºN, 113.53871ºW) is located in the Lemhi Range, approximately 8 km east of Lemhi, ID. The reservoir has a surface area of 9.6 ha, sits at an elevation of 1,950 m, and is primarily used for irrigation water storage. Yearian Reservoir is located on private land, but the landowners allow fishing access to the general public. There is a naturally reproducing population of Rainbow Trout in the reservoir that likely originated from a stocking event in 1952, when 3,330 Rainbow Trout were stocked (unspecified strain) in Yearian Creek. This is the only documented stocking event in the drainage.

We set one pair of standard lowland lake gill nets (one sinking and one floating) (46 m x 2 m, with six panels consisting of 19, 25, 32, 38, 51, and 64 mm bar mesh) at Yearian Reservoir on the evening of April 7, 2015 to determine the composition, relative abundance, and size structure of the fish community. Fish caught in the gill nets were identified to species, enumerated, measured (mm TL), and weighed (g). Relative abundance (catch-per-unit-effort: CPUE) was calculated as the total number of fish caught, divided by the total number of gill net hours. Relative weight (W_r) was calculated using the same methods outlined above.

Yellowbelly Lake

Yellowbelly Lake (WGS84 datum: 44.00050ºN, -114.87677ºW) is an oligotrophic lake located in the Sawtooth Basin at 2,157 m elevation. The lake has 77.9 ha of surface area, a maximum depth of 24.5 m, and 8.4 km of shoreline. The principle in-flow is provided by Yellowbelly Lake Creek. Documented fish species in the lake are Brook Trout, Westslope Cutthroat Trout, Rainbow Trout, Bull Trout, Redside Shiner, Northern Pikeminnow *Ptychocheilus oregonensis*, and suckers (*Catastomus spp*). Yellowbelly Lake has historically been dominated by non-game fish species, and was chemically treated to remove all fish in 1960 and 1990. The lake was subsequently heavily stocked with trout after each chemical treatment, to establish a quality fishery, but failed on both occasions. In 2013, we doubled the number of Westslope Cutthroat Trout fry stocked annually, from approximately 40,000 to approximately 80,000, to try to establish a population in the lake. In 2014, 69,479 Westslope Cutthroat Trout fry were stocked.

We set four pairs of standard lowland lake gill nets (one sinking and one floating, per pair) (46 m x 2 m, with six panels consisting of 19, 25, 32, 38, 51, and 64 mm bar mesh) at Yellowbelly Lake on the evening of July 7, 2015 to determine the species composition of the fish community. Specifically, we wanted to determine if the increased stocking density of Westslope Cutthroat Trout in recent years has been effective at establishing a population. Fish caught in the gill nets were identified to species, enumerated, measured (mm TL), and weighed (g). Relative abundance (catch-per-unit-effort: CPUE) was calculated as the total number of fish caught, divided by the total number of gill net hours. Relative weight (W_r) was calculated using the same methods outlined above.

Zooplankton samples were collected at Yellowbelly Lake on August 21, 2015. Tows were conducted near the inlet, mid-lake, and at the outlet following methods outlined by Teuscher (1999). Tows were conducted from a depth of 9.1 m at all locations. Samples were stored and analyzed using the methods outlined above.

Williams Lake

Williams Lake (WGS84 datum: 45.01636°N, 113.97434°W) is located approximately 19 km south of Salmon, Idaho. The lake is 73 ha in size and sits at 1,600 m in elevation in the Lake Creek drainage of the upper Salmon River basin. Maximum depth is 56 m and mean depth is 23 m. The lake's inlet, Lake Creek, provides the majority of its water input and is a major spawning tributary for the lake's Rainbow Trout and Bull Trout populations. Degraded water quality in the late 1980s and early 1990s, attributed to increased nutrient input from eroded sediments in the watershed and leaching of septic systems, caused concern over the health of the lake's fish population (Liter et al. 2000). Early assessments found that winter dissolved oxygen concentrations can fall below 5 mg/L within 2-4 m of the surface, and within 8 m of the surface in summer (Liter et al. 2000). Eutrophication caused by leaching septic fields has been addressed in the last two decades, but the lake still experiences extremely low dissolved oxygen values below the epilimnion, making the lower depths of the lake uninhabitable to fish. Williams Lake is a mesotrophic lake that currently serves as a quality fishery in the Salmon area, and generally receives most of its angling pressure during ice-free months.

Since 2000, IDFG has been monitoring zooplankton quality and abundance in the lake in order to determine whether forage is a limiting factor affecting fish growth and survival. Zooplankton samples were collected at Williams Lake on August 17, 2015. Tows were conducted near the inlet, mid-lake, and at the outlet following methods outlined by Teuscher (1999). Tows were conducted from a depth of 9.1 m at all locations. Samples were stored and analyzed using the methods outlined above.

Herd Lake

Herd Lake (WGS84 datum: 44.08921˚N, 114.17364˚W) is located in the East Fork Salmon River drainage in Custer County at 2,187 m elevation and was formed by a prehistoric landslide which blocked Lake Creek. The lake has a surface area of 6.7 ha and supports a self-sustaining population of Rainbow Trout that spawn in Lake Creek. Gill netting efforts between 2001 and 2011 showed that average Rainbow Trout length in Herd Lake rarely exceeded 250 mm TL (Curet et al. 2013), which was considered a result of an overabundance of fish and resulting competition for forage (Brimmer et al. 2003). In an effort to reduce Rainbow Trout abundance and improve size structure, 72 tiger muskellunge were stocked in 2006 and the bag limit on Rainbow Trout was increased from six to 25 trout per day in 2011. In 2013, and additional 75 tiger muskellunge were stocked (Messner et al. 2015). We have been monitoring zooplankton quality and abundance since 2002 in Herd Lake.

Zooplankton samples were collected at Herd Lake on August 19, 2015. Tows were conducted near the inlet, mid-lake, and at the outlet following methods outlined by Teuscher

(1999). Tows were conducted from a depth of 7.7 m at all three locations. Samples were stored and analyzed using the methods outlined above.

RESULTS AND DISCUSSION

Mosquito Flat Reservoir

A total of 76.4 hours of gill netting resulted in 65 fish captured in 2015 (CPUE = 0.85 fish/hr) (Table 17). Species composition in the gill nets was 54% Rainbow Trout (n = 35) (CPUE = 0.46 fish/hr), 45% Brook Trout (n = 29) (CPUE = 0.38 fish/hr), and <1% Bull Trout (n = 1) (CPUE = 0.01 fish/hr) (Figure 23). No other species were caught.

There appeared to be a minimum of two size classes of Rainbow Trout and two size classes of Brook Trout present in the reservoir in May, 2015, before seasonal stocking had begun (Figure 24). Rainbow Trout ranged in size from 252 to 337 mm TL (mean 289.5 mm TL) and relative weight values ranged from 53 to 95 (mean W_r = 68) (Figure 25). Brook Trout ranged in size from 172 to 274 mm TL (mean 214.8 mm TL) and relative weights ranged from 57 to 94 (mean W_r = 68).

Species composition and size structure comparisons with previous years gill netting surveys at Mosquito Flat Reservoir are difficult, as gill netting in previous years took place after catchable Rainbow Trout had been stocked. However, the last time the fish community was sampled at Mosquito Flat Reservoir, in 2002 (six days after approximately 1,500 catchable Rainbow Trout were stocked), Rainbow Trout relative abundance was twice as high (CPUE = 0.91 fish/hr) and Brook Trout relative abundance was 75% less (CPUE = 0.08 fish/hr) (Table 17, Figure 24). Body condition of Rainbow Trout in June 2002 (W_r = 66 to 126, mean = 96) was better than in 2015, but many of those fish likely came from the hatchery and were on feed just prior to capture. Body condition for Brook Trout was similar in June 2002 (W_r = 30 to 96, mean = 56). The timing of our capture (just after ice-off) in 2015 likely contributed to low overall body condition for both species, due to cold temperatures and low food availability during winter months.

During zooplankton sampling in August, 2015 total biomass was 1.81 grams/liter, ZPR was 0.50, and ZQI was 0.77 (Table 18, Figure 25). Based on previous years' zooplankton surveys and index guidelines presented by Teuscher (1999) (Table 19), it appears competition for forage resources in Mosquito Flat Reservoir has been reduced in recent years, and it is uncertain as to whether food is limiting (Figure 25).

In 2016, we intend to start stocking sterile Kokanee Salmon fingerlings into Mosquito Flat Reservoir to establish a unique fishery for the area. Kokanee were stocked once before at the reservoir, in 1995 (4,072 fry from Fishhook Creek), but were not successful at surviving and establishing a fishery (Liter et al. 2000). A combination of factors may have contributed to their unsuccessful establishment in 1995. First, Brook Trout were abundant in the reservoir and may have led to high rates of predation on Kokanee fry. Brook Trout abundance has since been reduced (Figure 23), when the fish community in the Challis Creek Lakes (headwaters of Challis Creek) shifted from Brook Trout to Westslope Cutthroat Trout. Also during that time, fingerling Rainbow Trout were being stocked at very high densities (~10,000 per year), and zooplankton quality and abundance was very low (Figure 25) as a result. In the early 2000's fingerling Rainbow Trout stocking was discontinued, and zooplankton quality and abundance has since increased (Figure 25). Third, Kokanee were stocked as fry in 1995, and a later life stage (i.e. fingerlings or catchables) would likely exhibit better overall survival than those fry that were planted. We will stock fingerlings to hopefully increase chances of survival and successful establishment.

IDFG zooplankton index guidelines (Table 19) (Teuscher 1999) suggest the current abundance and quality of zooplankton in Mosquito Flat Reservoir could support stocking somewhere around 150 fingerlings per surface acre, which is approximately 6,000 fingerlings. We currently stock approximately 5,500 catchable Rainbow Trout per year in the reservoir to maintain a put-and-take trout fishery. Zooplankton surveys at Mosquito Flat Reservoir suggested competition for forage resources is likely in most years (Tables 18 and 19, Figure 25), and may be a limiting factor for fish production and growth (Esselman et al. 2007). Zooplankton surveys in 2015 suggest quality zooplankton are not overly abundant, which is why we may decrease early spring stocking of Rainbow Trout to reduce competition for limited resources. Therefore, we are considering decreasing the number of catchable Rainbow Trout stocked annually to increase the likelihood of survival for Kokanee fingerlings. Based on our 2015 survey results, winter carryover of Rainbow Trout should be sufficient to provide quality angling opportunity in the early spring. Continual monitoring will be necessary to track survival and growth of stocked Kokanee fingerlings, and determine whether further management action is needed to establish a Kokanee fishery.

Stanley Lake

We captured 54 fish in 107.65 hours of gill netting in 2015 (CPUE = 0.50 fish/hr) (Table 20). Species composition in the gill nets was 85% Kokanee Salmon (n = 46), 11% Lake Trout (n = 6), and 4% Rainbow Trout (n = 2). We did not catch any Bull Trout or Brook Trout in 2015, although they have been caught in previous surveys. Kokanee Salmon ranged in size from 205 to 270 mm TL (mean 235 mm TL). Lake Trout ranged in size from 350 to 902 mm TL (mean 657 mm TL) (Table 20, Figure 26). Rainbow Trout TL was 319 and 339 mm. Kokanee Salmon relative weights ranged from 62 to 77 (mean 69), Lake Trout relative weights ranged from 87 to 103 (mean 95) (Table 20), and Rainbow Trout relative weights were 70 and 71.

Relative abundance for Lake Trout captured in gill nets in 2015 (CPUE = 0.05 fish/hr) was similar to what was found during the last gill netting efforts in 2012 (CPUE = 0.05 fish/hr), and size distribution was similar as well (bimodal), although sample size was much lower in 2015 (Table 20, Figure 26). All Lake Trout we caught in gill nets in 2015 were at a depth of approximately 20 to 30 m, and were located approximately 10 to 20 m offshore. We caught four of the six (67%) Lake Trout on the east shore of the lake and two near the inlet. Four of the six fish (67%) were captured in sinking nets, suggesting Lake Trout were mostly bottom-oriented during our sampling period. The location of Lake Trout aggregations during spring months is typically associated with foraging behavior, whereas in late fall aggregations are usually associated with spawning behavior (Hansen et al. 2008). The lake had not yet stratified in May, 2015 (Figure 27), but when stratification occurs later in the spring, Lake Trout likely move into deeper cooler water below the thermocline (Scott and Crossman 1973). Summer telemetry work done by regional staff in 2012 showed that Lake Trout in Stanley Lake were dispersed throughout the lake during mid-summer months, but aggregate at the northeast end of the lake near the outlet in October and November for spawning (Flinders et al. 2013). Targeting spawning locations in the fall may be another viable option for effective sampling of Lake Trout in Stanley Lake.

During zooplankton sampling in August, 2015 we found total biomass was 0.04 grams/liter, ZPR was 0.07, and ZQI was 0.00 (Table 21). Based on these findings, primary forage resources are extremely limited in Stanley Lake (Table 19), which likely explains small size and low relative weights for Kokanee Salmon in the lake.

The Lake Trout fishery in Stanley Lake has come under scrutiny in recent years, due to the amount of effort being spent on Sockeye Salmon *Oncorhynchus nerka* recovery in the Sawtooth Basin, and the perceived threat of Lake Trout on accomplishing these objectives. Currently, regional staff are developing a management plan for Stanley Lake to alleviate concerns over the possibility of Lake Trout expansion into other lakes in the drainage which may pose possible threats to established Bull Trout and Sockeye Salmon populations through competition and/or predation, along with angler considerations to the elimination of a trophy lake trout fishery are all being considered. Possible options to consider, if Lake Trout removal is deemed justified or necessary, include the use of daughterless lake trout technology, rotenone treatment, and/or mechanical removal via gill netting. Maintaining the current management of the lake may also be a viable option (i.e. a do nothing approach). In preparation for conducting a comprehensive study on the Lake Trout community in Stanley Lake, we wanted to determine where Lake Trout could be effectively sampled with gill nets during the spring months. Results from our 2015 gill netting efforts show Lake Trout can be effectively sampled with gill nets in nearshore areas of the lake in early spring, especially along the east shoreline. This information will help us form a study design to assess Lake Trout abundance, size/age structure, and population dynamics over the next few years.

Yearian Reservoir

We caught 108 Rainbow Trout during 34 hours of gill netting in 2015 (CPUE = 3.18 fish/hr). There appeared to be a minimum of three size-classes of Rainbow Trout in the reservoir (Figure 28). Lengths ranged from 172 to 375 mm TL (mean 259.9 mm TL) and relative weights ranged from 53 to 93 (mean 75) (Figure 28). Although relative weights were relatively low (W_r = 100 is considered average for the species) we sampled the reservoir shortly after ice-off, when forage is typically limited and body condition may be lower than during the rest of the year.

The Rainbow Trout population in Yearian Reservoir is naturally reproducing and multiple size classes are present (Figure 28). As the reservoir is located on private land, and is primarily used for irrigation, fisheries management actions to improve fish size are unlikely. However, the landowners that maintain the reservoir have expressed a willingness to allow public access for fishing and other recreational activities. Our survey suggests this is a great location to send anglers early in the spring to produce high catch rates for naturally reproducing Rainbow Trout. We recommend working with the landowners to increase public use of the reservoir and its fish resources and potentially secure a long-term access agreement.

Yellowbelly Lake

We caught 112 fish in 131.2 hours of gill netting in Yellowbelly Lake in 2015 (CPUE = 0.85 fish/hr). Species composition in gill nets was 73% sucker spp. (n = 169), 22% Northern Pikeminnow (n = 52), 2% Rainbow Trout (n = 5), 2% Bull Trout (n = 5), and <1% Brook Trout (n = 2) (Figure 29). Rainbow Trout ranged in size from 359 to 392 mm TL (mean 372 mm TL), and relative weights ranged from 68 to 77 (mean 73).

During zooplankton sampling in August, 2015 we found total biomass was 0.23 grams/liter, ZPR was 0.13, and ZQI was 0.03 (Table 22, Figure 30). Based on these findings, primary forage resources are extremely limited in Yellowbelly Lake (Table 19), and have been very limited for the past 9 years (Figure 30), which may have contributed to failed efforts to establish a Westslope Cutthroat Trout population through extensive fingerling planting.

Gill net catch compositions at Yellowbelly Lake over the past 50+ years have been dominated by non-game fish (i.e. Northern Pikeminnow and sucker spp), with the exception of 2001 when Brook Trout dominated the catch (Figure 29). We have stocked approximately 231,500 Westslope Cutthroat Trout fry (TL <76 mm) in Yellowbelly Lake over the last three years, but have not encountered any in our gill netting surveys. Establishment of a Westslope Cutthroat Trout fishery in Yellowbelly Lake is unlikely to occur with the current stocking program, and those fish could be better utilized in other water bodies. We recommend exploring other options for establishing a quality trout fishery in Yellowbelly Lake. The Rainbow Trout we caught in 2015 appeared very healthy and likely originated from a stocking event in June, 2013, when approximately 1,500 catchable Rainbow Trout were planted. Based on an estimated average stocking size of 250 mm TL, those catchable Rainbow Trout stocked in 2013 grew an average 60 mm TL per year over the last two years. Body condition for Rainbow Trout caught in 2015 was fair, but this can be expected with an oligotrophic lake dominated by a high abundance of non-game fish (i.e. sucker and Northern Pikeminnow), with limited forage resources. We are not as concerned at this time with trout body condition, as we are with establishing an abundant population of trout that are available to anglers. The Rainbow Trout caught in 2015 could provide an adequate fishery if they were in higher abundance. As a result, we should explore the possibility of stocking higher densities of catchable Rainbow Trout in the lake to establish a trout fishery. Once we determine how a trout population can be established in the lake, we may experiment with ways to decrease biomass of non-game fish to decrease competition, and improve growth rates and body condition for trout.

Williams Lake

During zooplankton sampling in August, 2015 we found mean total biomass was 5.50 grams/liter, ZPR was 0.50, and ZQI was 2.46 (Table 23, Figure 31). Based on findings from previous years' zooplankton surveys and index guidelines presented by Teuscher (1999) (Table 19), it appears competition for forage resources in Williams Lake is currently unlikely (Figure 31).

Zooplankton indices have been fairly consistent in Williams Lake over the past 16 years (Figure 31). The increased ZQI value observed in 2015 may be a result of sampling error thus, re-sampling in 2016 is necessary to determine if the abundance of large-bodied zooplankton is in fact increasing in Williams Lake. This could have large implications on fish growth in 2016.

Herd Lake

During zooplankton sampling in August, 2015 we found mean total biomass was 2.38 grams/liter, ZPR was 0.26, and ZQI was 0.31 (Table 24, Figure 32). Based on findings from previous years' zooplankton surveys and index guidelines presented by Teuscher (1999) (Table 19), it appears competition for forage resources in Herd Lake is currently occurring (Figure 32).

Although forage quality and abundance was extremely good in 2013, we have observed a steady decline in the last two years (Figure 32) that may be indicative of a recent increase in Rainbow Trout abundance. The fish community should be sampled in 2016 to measure relative abundance and size structure and the relationship to forage quality and abundance.

MANAGEMENT RECOMMENDATIONS

1. Stock approximately 6,000 sterile triploid Kokanee Salmon fingerlings in Mosquito Flat Reservoir in 2016, and periodically monitor growth and survival.

2. Continue annual zooplankton monitoring at Mosquito Flat Reservoir.

3. Work with other agency staff and experts to develop a model for describing the Lake Trout population in Stanley Lake over the next few years.

4. Work with the landowners at Yearian Reservoir (Shiner Ranch LLC – Lemhi, Idaho) to promote increased angler effort at the reservoir during spring and summer months.

5. Evaluate growth and survival of stocked catchable-sized Rainbow Trout at Yellowbelly Lake in 2016 to determine if this is a viable option for creating a fishery.

6. Perform a mark/recapture population estimate for the fish community in Herd Lake in 2016 to determine how the Rainbow Trout population has responded to the introduction of Tiger Muskellunge.

7. Continue annual zooplankton monitoring at Herd Lake to evaluate forage quality and abundance as it relates to fish abundance.

Table 17. Catch compositions and catch-per-unit-effort (CPUE: fish/hr) for all species encountered during gill netting surveys at Mosquito Flat Reservoir, 1979 to 2015. EBT = Eastern Brook Trout, WCT = Westslope Cutthroat Trout, RBT = Rainbow Trout, and BUT = Bull Trout.

			# caught					CPUE (fish/hr)				
Year	# nets	Net hours	EBT	WCT	RBT	BUT	Total	EBT	WCT	RBT	BUT	Total
1979	2	24.00	35	0	7	0	42	1.46	0.00	0.29	0.00	1.75
1991	2	38.00	5	0	7	0	12	0.13	0.00	0.18	0.00	0.32
1992	2	35.60	57	0	24	0	81	1.60	0.00	0.67	0.00	2.28
1993	8	60.03	73	1	8	0	82	1.22	0.02	0.13	0.00	1.37
1996	2	24.00	29	0	142	0	171	1.21	0.00	5.92	0.00	7.13
2000	2	32.50	12	1	120	3	136	0.37	0.03	3.69	0.09	4.18
2001	2	27.75	1	0	114	1	116	0.04	0.00	4.11	0.04	4.18
2002	4	49.50	4	0	45	2	51	0.08	0.00	0.91	0.04	1.03
2015	4	76.40	29	0	35	1	65	0.38	0.00	0.46	0.01	0.85

Table 18. Summary of zooplankton sampling at Mosquito Flat Reservoir, 2000 to 2015.

Sampling date	8/15 2000	8/28 2001	8/19 2002	8/19 2003	8/17 2005	8/18 2015
Mean total biomass (g/L)	2.34	1.64	1.58	--	0.53	1.81
Mean zooplankton ratio (ZPR)	0.07	0.15	0.33	0.80	0.33	0.50
Mean zooplankton quality index (ZQI)	0.17	0.23	0.32	0.45	0.20	0.77

Table 19. Guidelines for stocking lakes and reservoirs based on ZQI and ZPR indices, as proposed in Teuscher (1999).

Index	Values	Meaning	Stocking recommendation
ZPR	<0.25	Limited forage	Stock only catchables
	0.25-0.60	Competition may be occurring	Stock fingerlings at 75-150 per acre
	>0.60	Competition unlikely	Stock fingerlings at 150-300 per acre
ZQI	<0.10	Limited forage	Stock only catchables
	0.10-0.60	Competition may be occurring	Stock fingerlings at 75-150 per acre
	>0.60	Competition unlikely	Stock fingerlings at 150-300 per acre

Table 20. Summary statistics for Kokanee Salmon and Lake Trout captured during gill netting surveys at Stanley Lake, 2007 to 2015, including relative abundance (CPUE: fish/hr), total length, and relative weights (W_r).

		Kokanee Salmon							Lake Trout						
Year	Gill net hrs	*n*	CPUE	Mean TL (mm)	SE TL	Max TL	Mean W_r	SE W_r	*n*	CPUE	Mean TL (mm)	SE TL	Max TL	Mean W_r	SE W_r
2007	164.5	20	0.12	234.2	5.8	276	68.3	1.9	44	0.27	651.2	21.3	930	97.5	4.5
2010	111.5	46	0.41	214.7	2.5	271	69.0	1.1	18	0.16	689.0	42.2	915	93.7	3.5
2011[a]	428.2	40	0.09	214.6	2.8	252	65.9	1.1	37	0.09	679.5	35.5	1017	95.8	2.5
2012[a]	4069.5	343	0.08	204.7	1.4	336	68.7	1.1	203	0.05	551.1	14.5	1005	92.3	2.2
2015	107.6	46	0.43	234.7	3.0	270	69.0	0.5	5	0.05	657.0	114.4	902	95.0	3.4

[a] gill netting during these years was aimed at capturing only Lake Trout, which is likely why Kokanee Salmon CPUE was very low.

Table 21. Summary of zooplankton sampling at Stanley Lake in 2015.

Sampling date	8/20 2015
Mean total biomass (g/L)	0.04
Mean zooplankton ratio (ZPR)	0.07
Mean zooplankton quality index (ZQI)	0.00

Table 22. Summary of zooplankton sampling at Yellowbelly Lake, 2007 to 2015.

Sampling date	8/23 2007	8/28 2008	8/27 2009	8/22 2011	8/16 2012	8/21 2015
Mean total biomass (g/L)	0.15	0.12	0.29	0.38	0.25	0.23
Mean zooplankton ratio (ZPR)	0.22	0.40	0.10	0.32	0.27	0.13
Mean zooplankton quality index (ZQI)	0.01	0.03	0.02	0.06	0.05	0.03

Table 23. Summary of zooplankton sampling at Williams Lake, 2000 to 2015.

Sampling date	8/22 2000	8/13 2001	8/19 2002	8/19 2003	8/17 2005	8/18 2008	8/31 2009	8/31 2010	8/19 2011	8/13 2012	8/18 2014	8/17 2015
Mean total biomass (g/L)	1.12	1.83	1.60	0.28	0.50	1.00	1.10	0.70	1.10	2.00	1.20	5.50
Mean zooplankton ratio (ZPR)	0.86	0.65	0.69	1.55	0.71	0.80	0.52	0.62	0.53	0.61	0.72	0.50
Mean zooplankton quality index (ZQI)	0.67	0.92	0.66	0.72	0.56	0.73	0.70	0.23	0.61	1.20	0.72	2.46

Table 24. Summary of zooplankton sampling at Herd Lake, 2002 to 2015.

Sampling date	8/27 2002	7/31 2003	8/9 2004	8/24 2006	8/24 2007	8/29 2008	8/31 2009	8/26 2011	8/17 2012	8/15 2013	8/20 2014	8/19 2015
Mean total biomass (g/L)	1.34	1.34	--	0.95	3.21	0.86	1.36	1.02	4.23	1.94	2.82	2.38
Mean zooplankton ratio (ZPR)	0.05	0.05	0.02	0.14	0.50	1.02	0.36	0.16	0.44	0.94	0.49	0.26
Mean zooplankton quality index (ZQI)	0.01	0.01	0.04	0.02	1.28	0.98	0.22	0.05	1.63	2.42	0.87	0.31

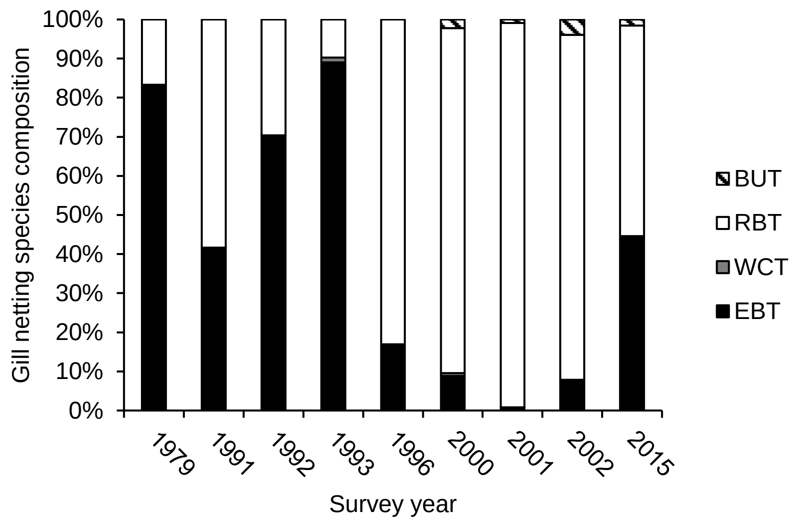

Figure 23. Species compositions for fish encountered during gill netting surveys at Mosquito Flat Reservoir, 1979 to 2015. EBT = Eastern Brook Trout, WCT = Westslope Cutthroat Trout, RBT = Rainbow Trout, and BUT = Bull Trout.

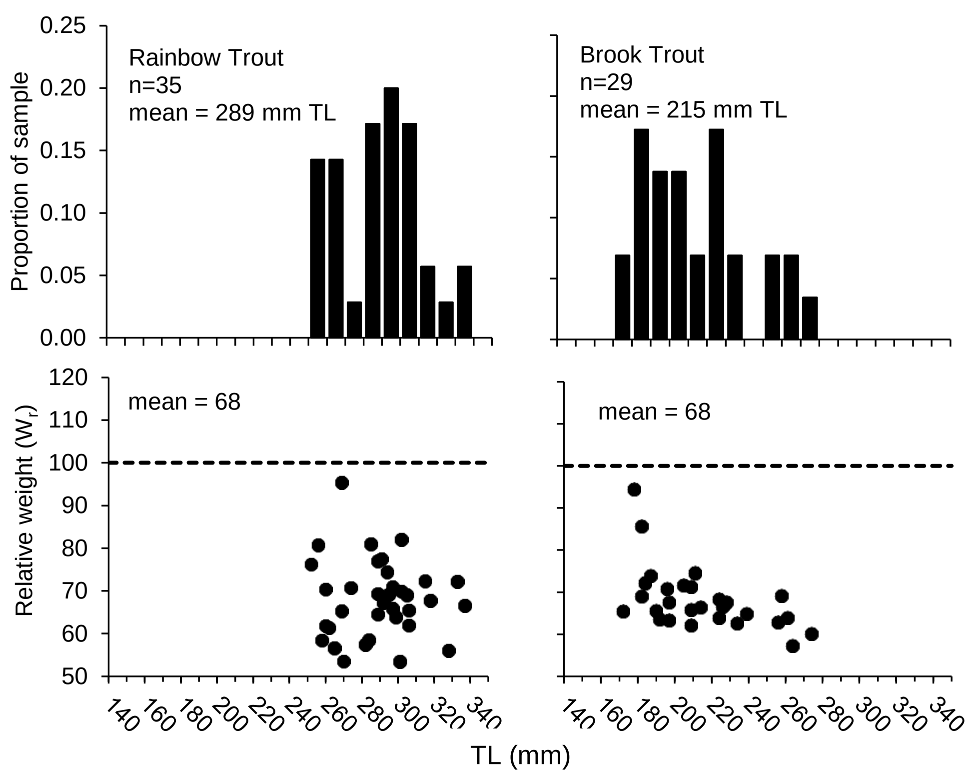

Figure 24. Length-frequency and length-relative weight relationships for Rainbow Trout and Brook Trout sampled during gill netting at Mosquito Flat Reservoir, May 2015.

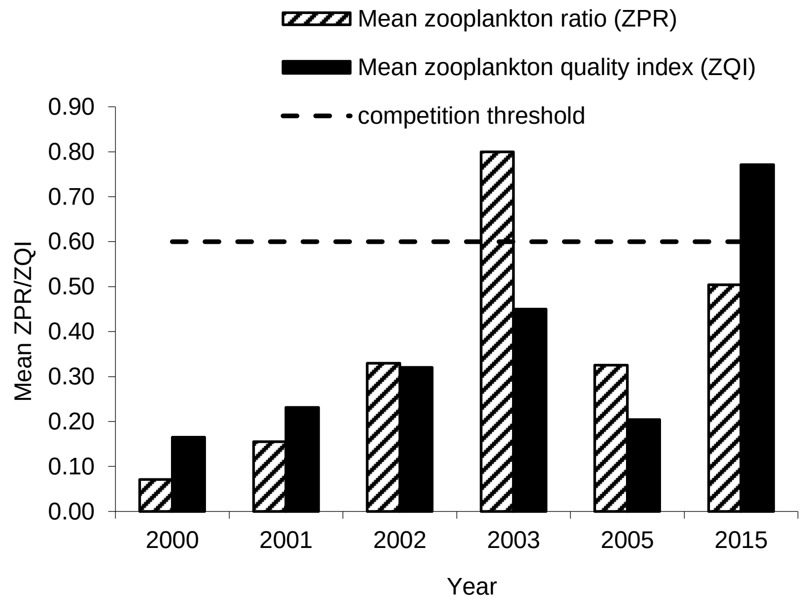

Figure 25. Zooplankton Ratio (ZPR) and quality index (ZQI) at Mosquito Flat Reservoir, 2000 to 2015, shown in relation to the threshold for defining whether or not competition is likely occurring (0.60). Values above this line indicate competition for food is unlikely.

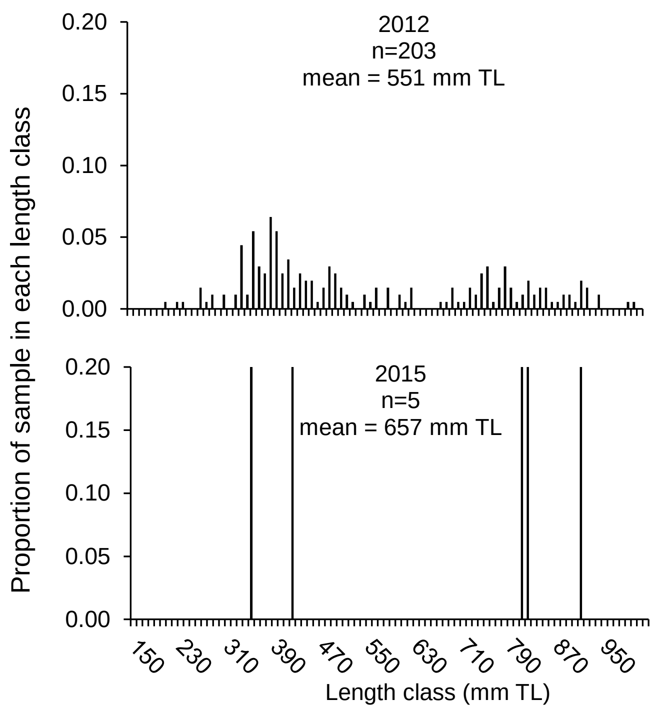

Figure 26. Lake Trout length-frequencies from sampling at Stanley Lake in 2012 and 2015.

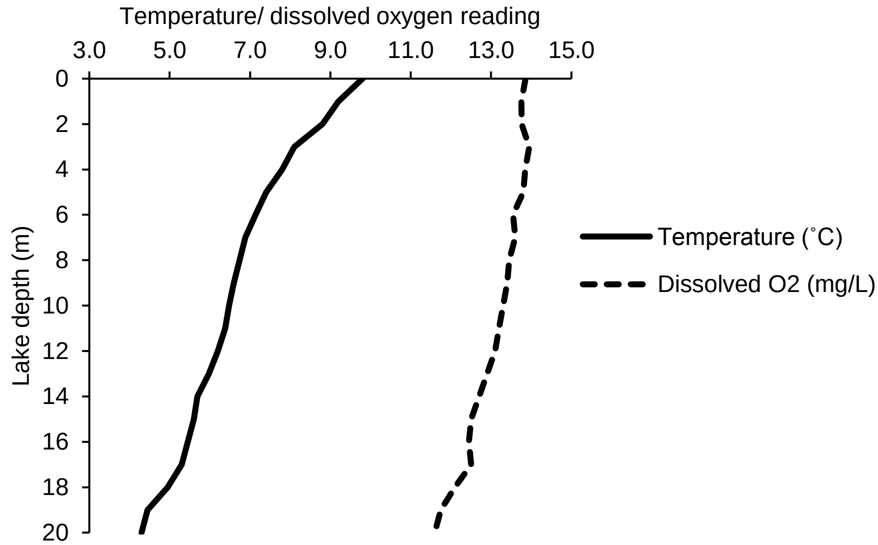

Figure 27. Temperature (°C) and dissolved oxygen (mg/L) profiles measured at mid-lake in Stanley Lake on May 21, 2015.

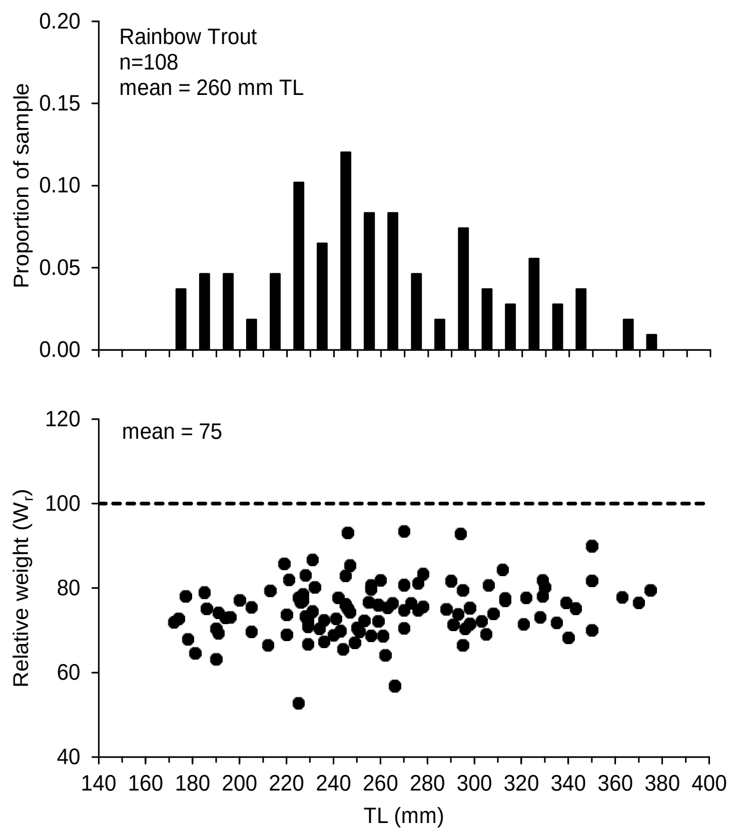

Figure 28. Length-frequency and length-relative weight relationships for Rainbow Trout sampled during gill netting at Yearian Reservoir, April 2015.

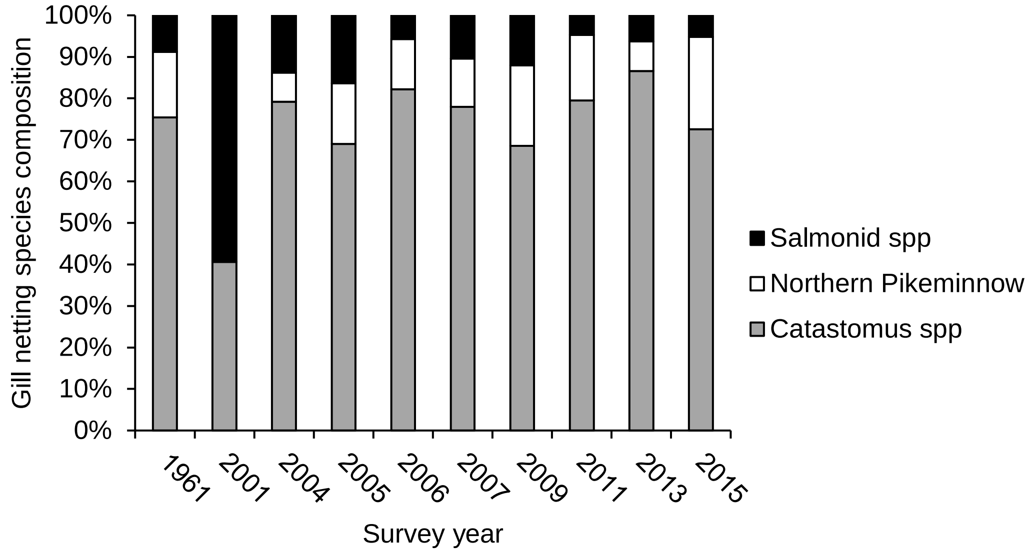

Figure 29. Catch compositions from gill netting surveys at Yellowbelly Lake, 1961 to 2015. Brook Trout were the dominant salmonid in 2001.

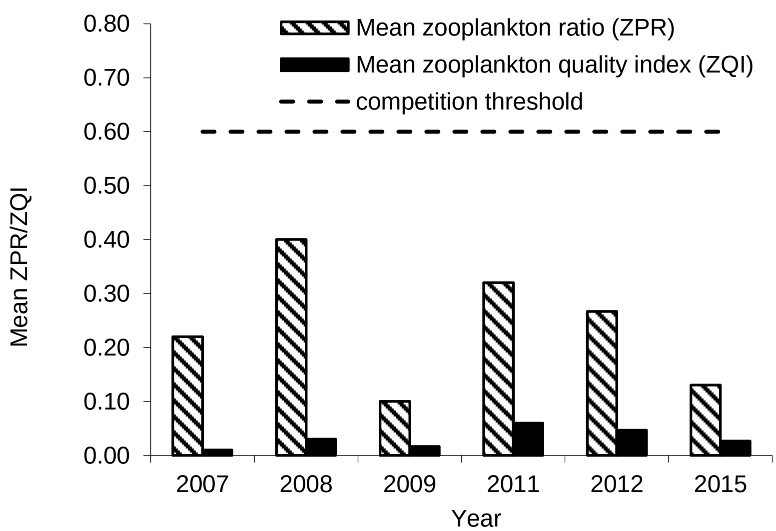

Figure 30. Zooplankton Ratio (ZPR) and quality index (ZQI) at Yellowbelly Lake, 2007 to 2015, shown in relation to the threshold for defining whether or not competition is likely occurring (0.60). Values below this line indicate competition for food is highly likely.

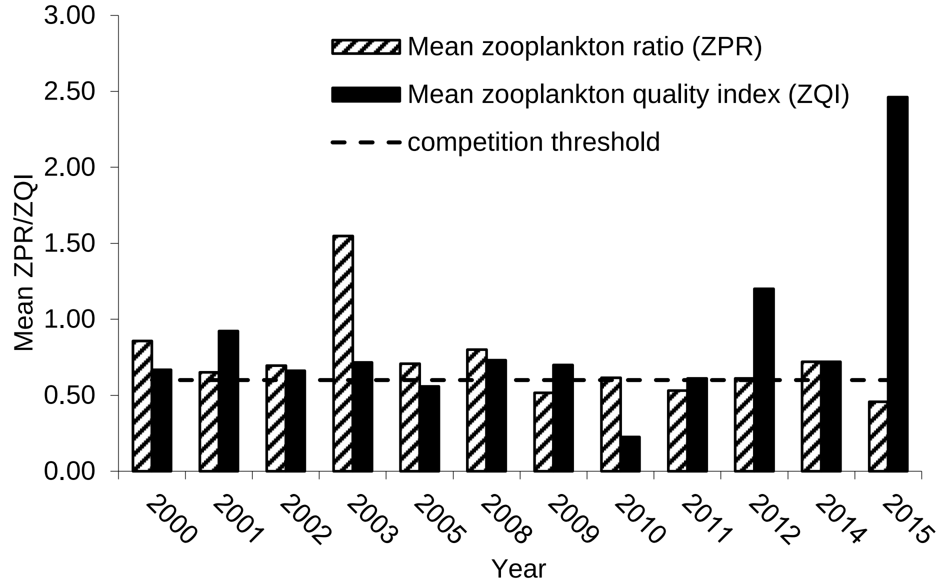

Figure 31. Zooplankton Ratio (ZPR) and quality index (ZQI) at Williams Lake, 2000 to 2015, shown in relation to the threshold for defining whether or not competition is likely occurring (0.60). Values above this line indicate competition for food is unlikely.

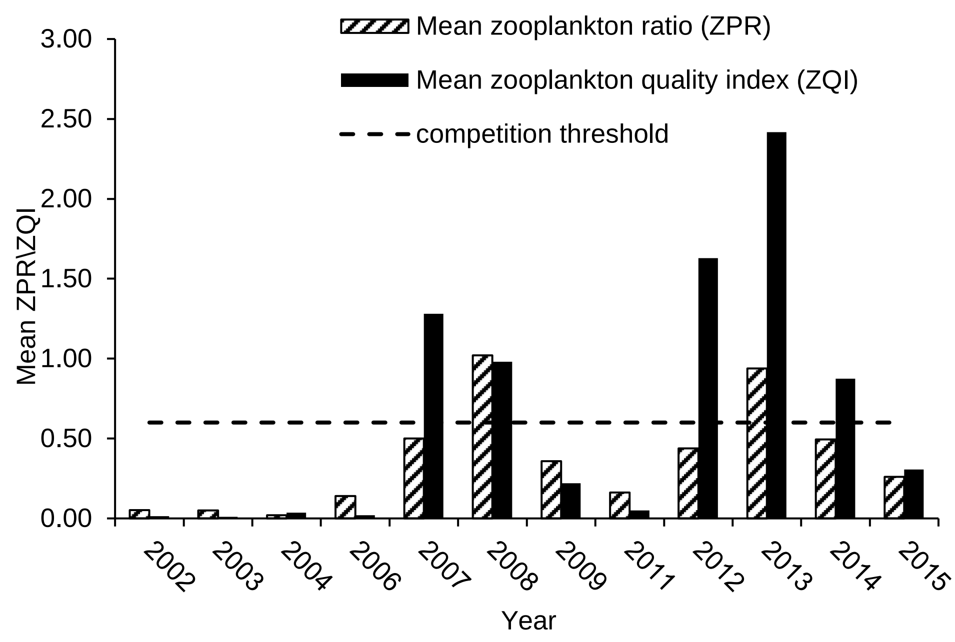

Figure 32. Zooplankton Ratio (ZPR) and quality index (ZQI) at Herd Lake, 2002 to 2015, shown in relation to the threshold for defining whether or not competition is likely occurring (0.60). Values above this line indicate competition for food is unlikely.

LOWLAND LAKES AND RESERVOIRS:

JIMMY SMITH LAKE RAINBOW TROUT FISHERY

ABSTRACT

We are monitoring the structure and abundance of Rainbow Trout in Jimmy Smith Lake to determine the effects of increased bag limits (from 6 per day to 25 per day) in 2011. We set four gill nets (two sinking and two floating) overnight at Jimmy Smith Lake in mid-July 2015 to assess relative abundance, size structure, and age and growth of the Rainbow Trout population. In 2015, we found that relative abundance of Rainbow Trout (4.32 fish/hr) remained similar to values observed during the last two sampling events (2012 and 2014), but size structure had improved substantially. The proportion of quality-size trout (> 300 mm TL) had increased from 0% in 2012 and 33% in 2014, to 61% in 2015. Mean total length was the highest observed to date (mean TL = 289 mm). We also found that fish growth has improved in the lake, as mean length-at-age 2, age 3, and age 4 had increased substantially.

Zooplankton quality and abundance was also assessed at Jimmy Smith Lake in 2015. Since the Rainbow Trout bag limit was increased, we have observed the highest quality conditions for trout growth during the past four sampling periods (2012-2015) of the twelve years sampled.

An angler effort survey was conducted during the winter ice fishery to determine the value and use of the fishery. From December 4, 2014 to March 20, 2015 we used remote trail cameras to enumerate anglers on the lake. During that period, we counted 796 hours of angling effort, and angler interviews conducted during that time period resulted in an estimated overall catch rate of 3.0 fish/hr.

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John Loffredo, Regional Fisheries Technician

HISTORY AND INTRODUCTION

Jimmy Smith Lake supports a naturally reproducing Rainbow Trout *Oncorhynchus mykiss* population, likely originating from stocking events in the early 1930s (Flinders et al. 2013). From the 1960's to 2000, average total length of Rainbow Trout rarely exceeded 200 to 250 mm (winter creel information stored on hardcopy at regional office), presumably due to high population density and competition for forage (Brimmer et al. 2003). However, in 2000 there was a reported fish kill which reduced abundance and decreased competition for Rainbow Trout in the lake, which is thought to have caused the substantial increase in mean fish length that was observed from 2001 to 2003 (from 203 mm to 278 mm TL). Over the next several years, between 2003 and 2006, gill netting surveys indicated abundance was again increasing, and average fish size was decreasing. In 2006, we decided to actively reduce the trout population to reduce competition and improve growth. With public support, in 2011 we made major access improvements at the lake and increased the daily bag limit from 6 trout per day to 25 (Flinders et al. 2013). From 2011 to 2014, relative abundance of Rainbow Trout in the lake decreased (from 7.49 fish/hr to 4.89 fish/hr) and mean total length increased from 183 mm to 241 mm (Messner et al. 2016). Periodic monitoring is needed to determine whether additional management action is necessary to decrease competition for forage resources in the lake, improve growth rates for Rainbow Trout and maximize angler satisfaction.

Although we believe angler effort at Jimmy Smith Lake is enough to substantially decrease Rainbow Trout population abundance through harvest with increased bag limits, we do not have quantifiable evidence. Dozens of winter creel surveys were conducted at the lake in the 1960's, 1970's, and 1980's, but more recent creel data (2011) was gathered only during a 24-day period in June and July (Curet el at. 2013). Most of the angling effort at Jimmy Smith Lake is thought to occur during the winter (M. Clemenhagen IDFG, personal communication), and current angling effort information is lacking for that time of year. In 2015, we wanted to collect information on angler effort and catch rates at the lake during the ice fishery, to help assess the value of the fishery. For anglers in the Salmon Region, Jimmy Smith Lake offers an excellent opportunity to catch quality-size, naturally reproducing Rainbow Trout all year long.

OBJECTIVES

1. Evaluate if liberalizing bag limits have been effective to change relative abundance and size structure of the Rainbow Trout population.

2. Determine how Rainbow Trout growth rates have changed since regulation changes were imposed in 2011.

3. Continue monitoring forage quality and abundance to better understand how they affect fish growth.

4. Collect baseline information on angler effort and catch rates during the winter ice fishery.

STUDY AREA

Jimmy Smith Lake (WGS84 datum: 44.16907ºN, -114.40249ºW) is a landslide lake, located in north central Custer County, near Clayton, Idaho, at 1,948 meters elevation with a surface area of 26 hectares. The lake has one outlet and three inlet streams. The outlet stream, Big Lake Creek, is located at the southeast end of the lake and drains to the East Fork Salmon River. Two small inlet streams, Corral Creek and Jimmy Smith Creek, are located at the north end and east end of the lake, respectively, and the major inlet and spawning tributary, Big Lake Creek, enters from the northwest end of the lake.

Jimmy Smith Lake supports a naturally reproducing population of Rainbow Trout that likely originated from stocking events in the 1930s. Natural reproduction is so successful in the lake that it has been identified as a potential cause for low size attainment, due to stunting (Brimmer et al. 2003). No other fish species have been documented in the lake. The lake is highly productive, and is dominated by an abundance of aquatic macrophytes, large zooplankton, and amphipods. Ice fishing is very popular during winter months, but the lake can also offer excellent catch rates during ice-free months; typically from around mid-March to late-July, when thick algae blooms can cause fishing to slow down. It was previously reported that the lake is subject to occasional fish kills (Brimmer et al. 2003).

METHODS

In 2015, we set four gill nets (two sinking and two floating) for a combined total of 58.08 hours, overnight, to estimate relative fish abundance (CPUE) and collect size and age structure information on the Rainbow Trout population. Fish captured in the gill nets were enumerated, measured (mm TL) and weighed (g), and sagittal otoliths were taken from 72 fish (approximately 3-5 fish per 5 mm length class) for age and growth analysis. Otoliths were cleaned of debris and mucus, and stored in dry vials, then were mounted in epoxy and sectioned using an isometric saw (Beamish 1979; Casselman 1983). Sections were mounted on microscope slides and digitized under 25x to 40x magnification. Digital images were read by two independent technicians and if independent readers were not in agreement on an age, a referee session with a third reader was used to assign an age to the otolith. We also aged otoliths from 69 Rainbow Trout collected in 2006, using the same methods, for comparison. We built length-frequency histograms for each year that the Rainbow Trout population was sampled at Jimmy Smith Lake to describe trends in overall size structure. We also calculated proportional stock density to describe the relative proportion of “quality” size Rainbow Trout present each year (PSD-Q), using 300 mm TL as the “quality” minimum length cutoff (Gablehouse 1984).

Using the program Fishery Analyses and Modeling Simulator (FAMS) (Slipke and Maceina 2014), we constructed two age-length keys based on ages derived from otolith analysis (one from Rainbow Trout aged in 2006, and one from Rainbow Trout aged in 2015) in order to determine the proportion of fish of each age, in each length group, for both years. Mean length-at-age and variance was then calculated from the age-length keys according the methods outlined in Chapter 16 (Determination of Age and Growth) in Murphy and Willis (1996) for comparisons between the two years. The differences in mean length-at-age between the two years show how growth has changed as a result of the large reduction in population abundance.

Zooplankton sampling was conducted at Jimmy Smith Lake on August 29, 2015. Samples were collected near the inlet, mid-lake, and at the outlet following methods outlined by Teuscher (1999). The sample crew deviated from Teuscher’s methods by sampling the inlet and outlet at 3.0 m depth, and the mid-lake location at 4.4 m, as maximum depth in the lake is not more than 6.0 m. Samples were stored in 100% ethyl alcohol for twelve days, at which time ZPR/ZQI values were quantified using methods reported in Teuscher (1999). Total zooplankton biomass (grams/liter) at each site is quantified by weighing the dried contents of the 153 µm net and dividing by tow depth. The zooplankton ratio index (ZPR) is the ratio of preferred to useable zooplankton, and is calculated by dividing the dried weight of the 750 µm sample (preferred) by the dried weight of the 500 µm sample (useable). The zooplankton quality index (ZQI) is the index of overall abundance and size ratios, and is calculated by dividing the sum of weights for the 500 µm and 750 µm samples by ZPR. Average total biomass, ZPR, and ZQI are calculated for each lake by averaging across the three sampling locations at each lake.

From December 4, 2014 to March 20, 2015 we conducted a remote creel survey at Jimmy Smith Lake. We positioned three trail cameras to photograph the entire lake (Figure 33), All three cameras were set to take photos at the same time (every hour, on the hour) each day. We downloaded photos once a month and stored them at the regional office. To estimate daily angler effort, we first enumerated anglers in each photo and referenced between cameras to make sure no anglers were enumerated twice during any given hour. We then summed the total number of unique anglers observed per hour each day from the three cameras to determine the total daily anger effort. Daily counts were then summed for each month to arrive at monthly angler effort. Average catch rates were obtained from random interviews conducted by regional conservation officers when they visited the lake.

RESULTS AND DISCUSSION

During a combined 58.08 hours of gill netting on July 13 and 14, 2015, we captured 251 Rainbow Trout (CPUE 4.32 fish/hr) (Table 25). Trout ranged in size from 150 mm to 368 mm TL, and averaged 289 mm TL (SE ± 2.6) (Table 25). Although relative abundance of Rainbow Trout in 2015 remained similar to 2012 and 2014, mean TL was the highest ever observed at the lake and PSD-Q increased from 0% in 2012 and 33% in 2014, to 61% in 2015 (Table 25). The catch was dominated by age-3 and age-4 fish in 2015 (Figure 34). We found that in 2015, compared to 2006, Rainbow Trout grew approximately 35 mm longer on average by age-2, approximately 24 mm longer by age-3, and approximately 66.3 mm longer by age-4 (Table 26, Figure 35). Age-5 and age-6 fish in 2015 were smaller on average than they were in 2006, but that is likely because those fish hatched immediately after the fish kill in 2000 thus, they probably grew at extremely high rates for the first few years of their lives, while population abundance was very low.

Average total zooplankton biomass (contents of the 153µm net) was 5.9 grams/meter in 2015; with average ZQI and ZPR values of 1.05 and 0.26. Compared to 2014 zooplankton analysis, quality and abundance of forage has been reduced in the lake in 2015 (Table 27). However, ZQI values much greater than 0.60 indicate that competition for food is still unlikely (Teuscher 1999). ZQI increased substantially in 2012, at the same time gill netting surveys indicated a large reduction in fish abundance, and has continued to indicate high forage availability through 2015 (Figure 36).

After bag limits were increased to 25 fish per day in 2012, we have seen an abrupt decrease in relative trout abundance with increased mean total length (Figure 37), and substantial increases in the quality and abundance of zooplankton in the lake (Figure 36). The observed changes in the fish community are similar to what was observed after a fish kill in 2000 (Brimmer et al. 2003) that had reduced fish abundance in the lake, but have been more sustained thus far. Although fish population abundance and competition for zooplankton have become greatly reduced in the last four years, whether it is a result of increased angler harvest is unknown. In either case, fish growth has improved, the quality of the fishery has improved, and anglers currently have the opportunity to catch larger fish than have been available in Jimmy Smith Lake in at least several decades.

Results of our angling effort study showed ice anglers fished an estimated 796 hours during the entire sampling period in 2015. Effort was highest from January 16 to February 14 (346 hours fished), followed by December 17 to January 15 (292 hours), February 15 to March 16 (116 hours), and December 4 to 16 (42 hours) (Table 28). A winter creel census conducted from November 17, 1954 to April 15, 1955 estimated similar effort (804 hours fished), with the busiest angling periods occurring during the same months. Average catch rates obtained from twelve angler interviews in January, 2015 was 3.0 fish/hour (range 0.4 to 9.0), just below the average fish per hour estimated during the 1954/55 consensus (3.9 fish/hr).

Although angling pressure and overall catch rates at Jimmy Smith Lake during the 2014/15 winter creel period are very similar to those observed 60 years ago, anglers now have the opportunity to catch much larger fish. Whether increased angler harvest or some other set of biological factors have led to the reduction in fish abundance, continued monitoring will be necessary to evaluate future population dynamics and productivity, to ensure the current quality of the fishery is maintained.

MANAGEMENT RECOMMENDATIONS

1. Continue annual monitoring of the fish and zooplankton community in Jimmy Smith Lake to detect any significant changes in the lake that may reduce the quality of the fishery.

2. Make management changes as necessary to maintain the current quality of the fishery in terms of fish size and catch rates.

Table 25. Summary of gill netting surveys at Jimmy Smith Lake 1996 to 2015, including mark/recapture population estimate and size structure information. (TL = total length, W_r = relative weight)

	Abundance				Size structure			
Year	Gill net hours	# Fish caught	Relative abundance (CPUE)	Population Est (95% CI)	Mean TL (mm) (± SE)	Maximum TL (mm)	Mean W_r (± SE)	PSD-Q
1996	15.0	157	10.47	--	213 (--)	332	--	7%
2001	16.5	113	6.85	--	203 (--)	370	--	50%
2003	62.2	144	2.32	--	278 (--)	368	--	36%
2005	65.2	351	5.38	--	251 (3.0)	427	--	27%
2006	181.5	779	4.29	--	222 (1.9)	419	106.8 (0.5)	21%
2008	90.3	914	10.13	--	202 (1.1)	320	80.4 (0.3)	5%
2009	69.8	914	9.88	--	203 (1.2)	325	77.8 (1.5)	4%
2010	71.7	591	8.24	--	205 (1.2)	295	75.6 (1.1)	0%
2011	90.3	676	7.49	18,955 (10,540-36,970)	183 (0.9)	250	89.2 (0.4)	0%
2012	121.7	419	3.44	33,109 (15,796-75,589)	229 (1.8)	295	84.8 (0.6)	0%
2014	110.3	539	4.89	11,856 (8,030-18,324)	241 (2.4)	425	85.2 (0.3)	33%
2015	58.1	251	4.32	--	289 (2.6)	368	79.4 (0.6)	61%

Table 26. Mean length-at-age for Rainbow Trout sampled at Jimmy Smith Lake in 2006 and 2015, calculated from an age-length key from each year, according to methods outlined in Murphy and Willis (1996).

	Mean TL (mm) (± SE)	
Age	2006	2015
2	194.4 (42)	229.3 (62)
3	250.0 (45)	274.0 (65)
4	265.6 (44)	331.9 (138)
5	350.0 (142)	348.0 (--)
6	400.0 (15)	365.0 (--)

Table 27. Summary of zooplankton sampling at Jimmy Smith Lake 2002 to 2015. (ZPR = zooplankton ratio, ZQI = zooplankton quality index)

Sampling date	8/19 2002	8/1 2003	8/9 2004	8/24 2006	8/24 2007	8/29 2008	8/31 2009	8/26 2011	8/17 2012	8/15 2013	8/20 2014	8/19 2015
Mean total biomass (g/L)	2.84	2.24	--	0.95	3.15	1.41	2.53	1.43	6.24	5.08	6.07	5.88
Mean ZPR	0.00	0.11	0.03	0.23	0.16	0.25	0.05	0.07	0.24	0.30	0.57	0.26
Mean ZQI	0.00	0.17	0.03	0.15	0.02	0.02	0.01	0.05	2.02	1.97	4.59	1.05

Table 28. Angler effort summaries for the winter ice fishery at Jimmy Smith Lake, 1954/55 and 2014/15. *Note: surveyed period for 2014/15 was December 4 to March 20.

	Angler hours	
Period	1954/55	2014/15
November 17 to December 16	119	42*
December 17 to January 15	234	292
January 16 to February 14	222	346
February 15 to March 16	137	116
March 17 to April 15	92	0*
Total angler hours	804	796
Mean estimated catch rate	3.9	3.0

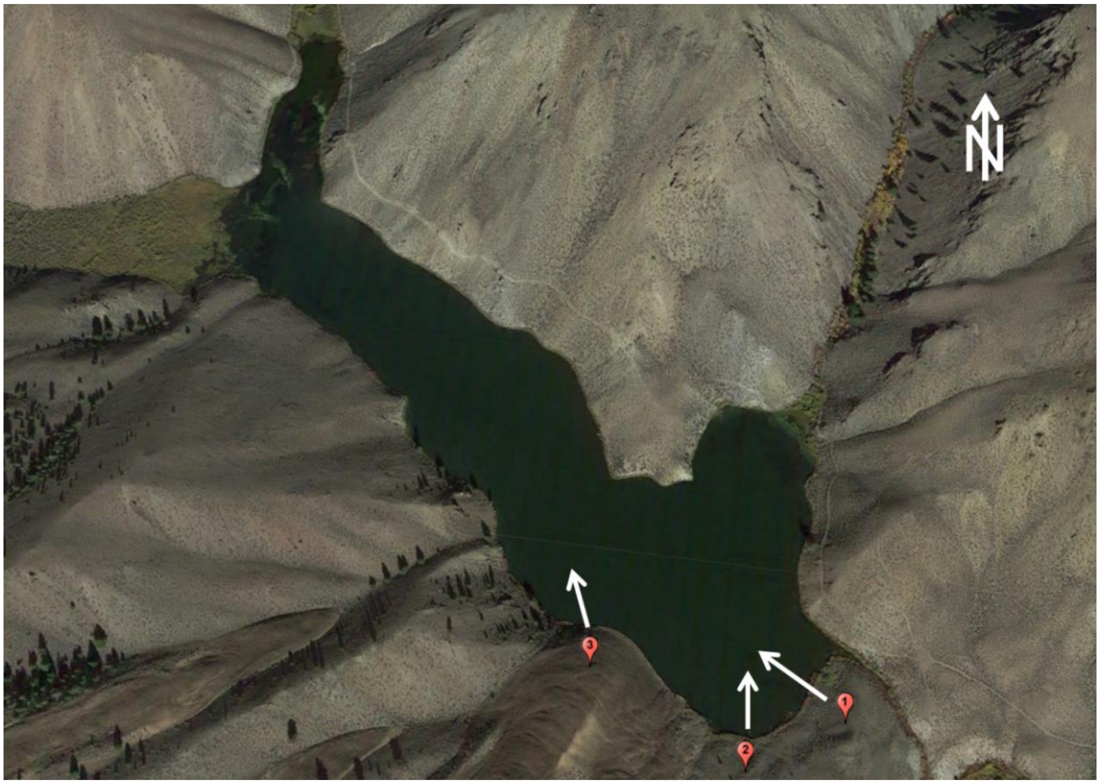

Figure 33. Camera locations and directions of view for estimating angler effort during the 2014/15 winter ice fishery at Jimmy Smith Lake.

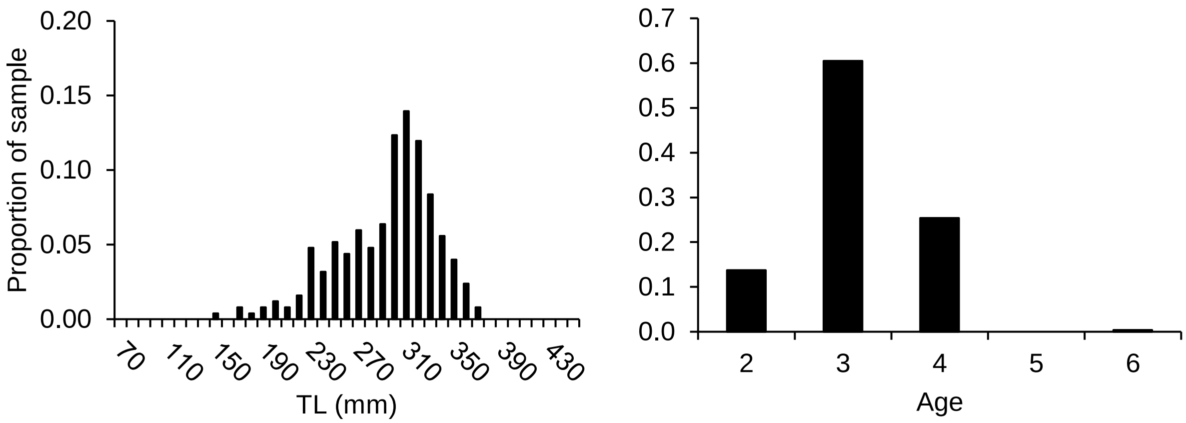

Figure 34. Length-frequency (left) and age-frequency (right) histograms for Rainbow Trout sampled at Jimmy Smith Lake in 2015.

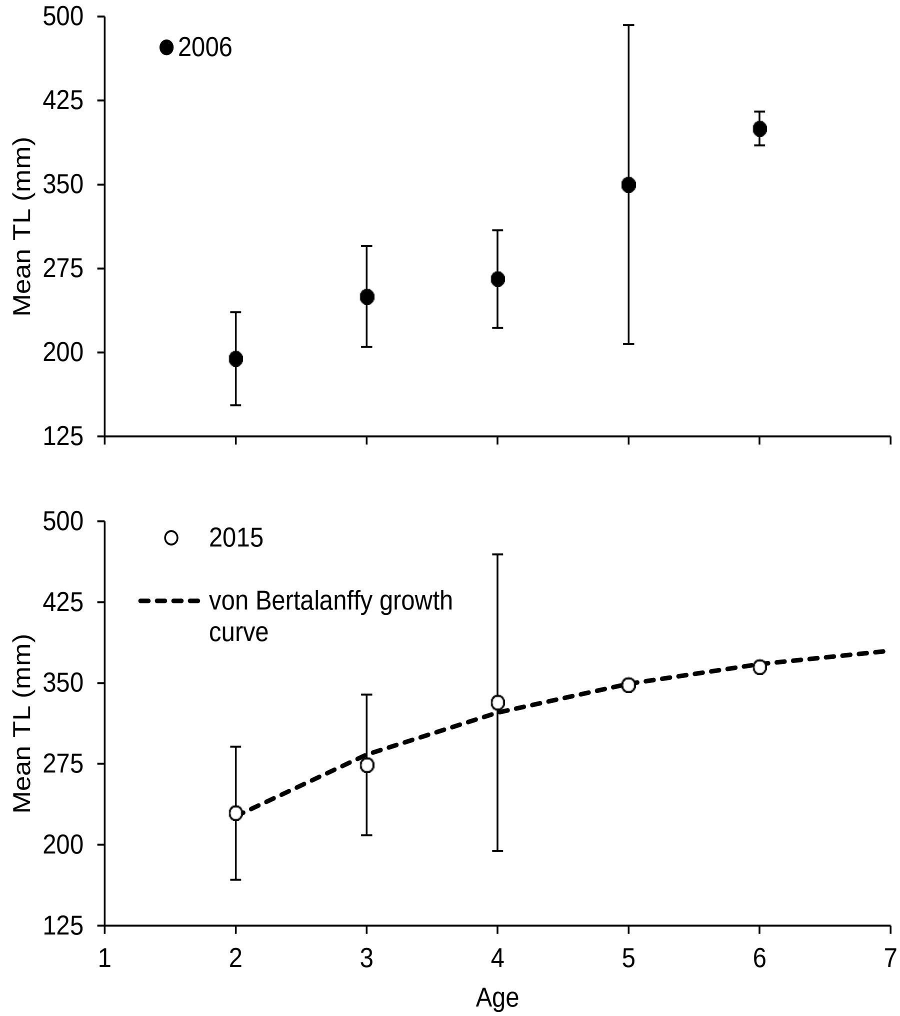

Figure 35. Mean length-at-age (TL) for Rainbow Trout sampled at Jimmy Smith Lake in 2006 and 2015, calculated based on age-length keys derived from otolith analysis. Von Bertalanffy growth variables for 2015 were calculated in FAMS (Slipke and Maceina 2014) (t_0 = -0.141, k = 0.38, and L_∞ = 406.914). No growth curve for 2006 due to spike in mean length-at-age for age-5 and age-6.

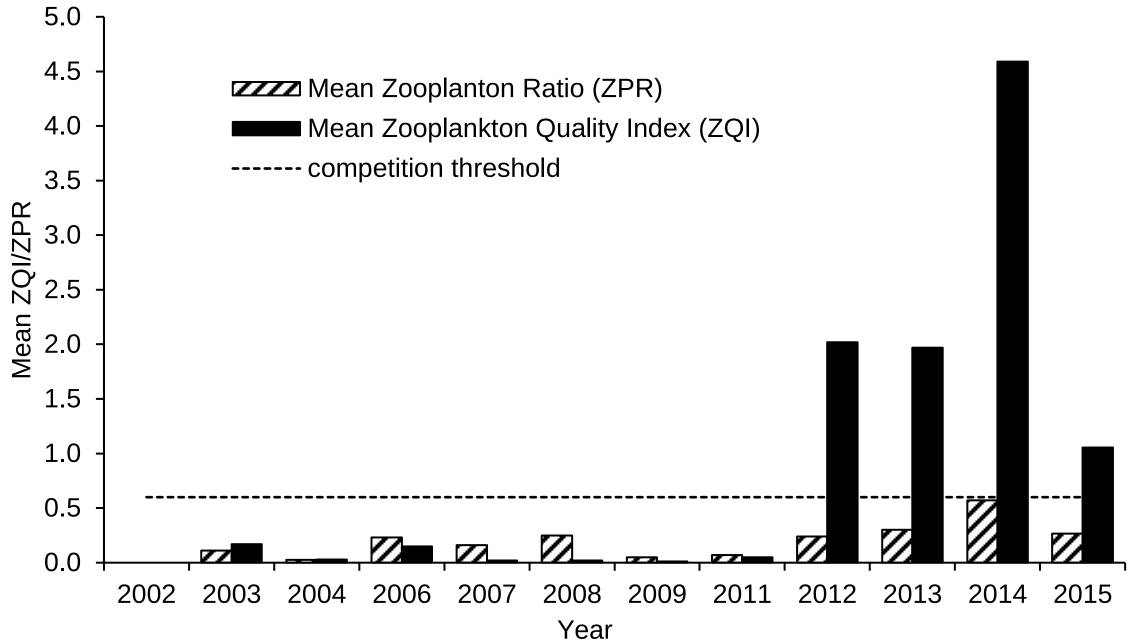

Figure 36. Zooplankton Ratio (ZPR) and quality index (ZQI) at Jimmy Smith Lake, 2002 to 2015, shown in relation to the threshold for defining whether or not competition is likely occurring (0.60). Values above this line indicate competition for food is unlikely.

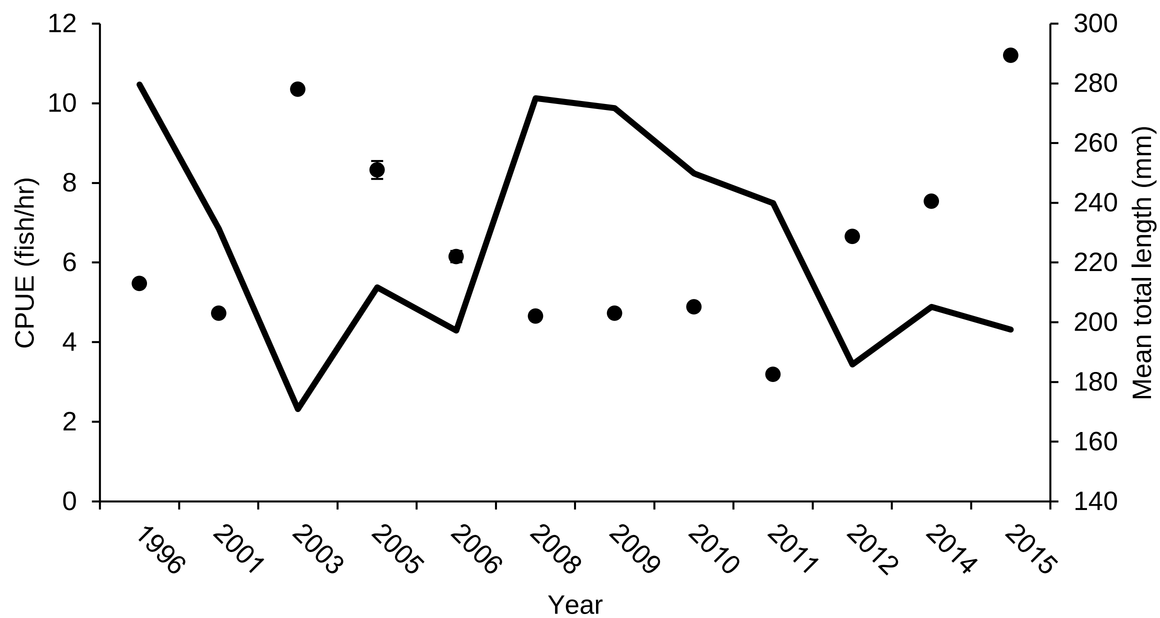

Figure 37. Estimated relative abundance (CPUE) (solid black line) and mean total length (black circles) of trout sampled from 1996 to 2015 at Jimmy Smith Lake.

LOWLAND LAKES AND RESERVOIRS:

CARLSON LAKE BROOK TROUT MONITORING

ABSTRACT

We conducted a population abundance estimate and age and growth study for Brook Trout *Salvelinus fontinalis* at Carlson Lake in 2015, to evaluate the effectiveness of tiger muskellunge *Esox masquinongy x Esox lucius* introductions aimed at improving Brook Trout size structure. Since the third tiger muskellunge stocking in 2013, Brook Trout abundance has been reduced approximately 75%, and size structure has improved as a result. Mean total length of Brook Trout in 2015 was the highest we have observed in over a decade of sampling (251.7 mm). Brook Trout growth rates have increased since 2006, as the relative proportion of younger age-classes in the population has decreased, likely decreasing competition for forage resources. Reduced abundance and increased growth rates for Brook Trout in 2015 may be a result of increased predation associated with higher tiger muskellunge stocking density in 2013 (approximately 35 fish/ha) relative to earlier stocking events (approximately 16-20 fish/ha). Brook Trout size structure is likely to continue showing improvement over the next few years at Carlson Lake, if densities continue to decline in the lake.

Author:

Jordan Messner, Regional Fisheries Biologist

HISTORY AND INTRODUCTION

Carlson Lake contains a naturally reproducing Brook Trout *Salvelinus fontinalis* population originating from stocking events in the 1940's and 1950's. Rainbow Trout *Oncorhynchus mykiss* were also stocked in the lake in 1975 and 1993, but those introductions failed. Anecdotal evidence suggests that, in the earliest years of the Brook Trout fishery in Carlson Lake, anglers reported catching trophy sized fish weighing up to 1.4 kg (Curet et al. 2000b). However, since 1975 Brook Trout population monitoring has indicated poor size and body condition, presumably from overabundance and related stunting (Messner et al. 2015). In the mid 1990's, fisheries staff attempted to reduce Brook Trout abundance through several different means (intensive gill netting, electrofishing, explosives, and increased bag limits) but all proved unsuccessful in obtaining long-term improvements to Brook Trout size structure (Brimmer et al. 2006). In 2002, forty-one tiger muskellunge *Esox masquinongy x Esox lucius* were introduced as a biological alternative for reducing Brook Trout abundance.

In 2002, when tiger muskellunge were first introduced, Brook Trout abundance was estimated at 9,024 fish (95% C.I. 7,474-11,064), with a mean TL of 201 mm. Three years after tiger muskellunge introduction, in 2005, Brook Trout abundance apparently decreased to 6,103 fish (95% C.I. 4,196-9,262), and average TL increased to 231 mm. The tiger muskellunge introduction was seemingly successful at reducing Brook Trout abundance and improving size structure for the first few years after introduction, and another 32 tiger muskellunge were stocked in the lake in 2006. However, mean length and condition of Brook Trout decreased from 2006 to 2009 (Curet et al. 2010), and continued to decrease into 2013, when the population was estimated at 10,867 (95% C.I. 9,182-13,008), the highest estimated abundance since monitoring began (Messner et al. 2015). To attempt a larger decrease in Brook Trout abundance and larger response in size structure, tiger muskellunge were stocked again in 2013, but at twice the number of the other two events (n=70). Angling surveys in 2014 found that mean total length increased slightly, but abundance was not measured.

In 2015, we used gill nets to conduct a mark/recapture population abundance estimate at Carlson Lake, and assess size structure of the Brook Trout population. We also used otoliths collected from Brook Trout in 2006 and 2015 to compare population age structure and growth rates over the last ten years, in response to tiger muskellunge predation.

OBJECTIVES

1. Estimate the current Brook Trout population abundance in the lake.
2. Determine if introducing tiger muskellunge has been successful at improving Brook Trout size structure.
3. Compare current age-structure and growth rates to ten years ago to determine if the Brook Trout population has responded following tiger muskellunge introduction.

STUDY AREA AND METHODS

Carlson Lake (WGS84 datum: 44.28153ºN, 113.75283ºW) is a sub-alpine lake approximately 3.5 hectares in size located in the Pahsimeroi River drainage at 2,438 m elevation. Subterranean flow from the lake drains into Double Springs Creek, a tributary of the Pahsimeroi River, but there is essentially no outlet and the inlet flow is seasonally intermittent. Carlson Lake has a highly vegetated littoral zone that extends for an average of approximately 12 meters from shore, and averages around 1 meter deep, around the entire perimeter of the lake. There is a primitive campsite with picnic bench and pit toilet located on the southwest end, by the inlet. The lake can be accessed from two different routes. From the northeast route, full size vehicles can drive to within approximately 2 km of the lake before alternative transportation is recommended. From the southwest route, full size vehicles can access the top of the ridge above the lake, but are not permitted to descend the remaining 1 km of road. Vehicle access to the lake and camping area is limited to ATVs, UTV's, and motorbikes only.

The survey crew angled Carlson Lake from June 17 to 21, 2015 to mark fish for the population estimate. Brook Trout were marked by cutting a notch in the upper lobe of the caudal fin. On the evening of June 21, six gill nets were deployed (three floating and three sinking) overnight for the recapture event. Fish captured in the gill nets were measured (TL mm), weighed (g), and examined for marks.

Brook Trout abundance ($\hat{N}$) was estimated using a Peterson single mark-recapture population estimate with the Chapman (1948) modification (Ricker 1975):

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1$$

where:

M = number of fish caught and marked in the first sampling period;
C = number of fish caught in the second sampling period and;
R = number of marked fish recaptured in the second sampling period.

Otoliths were taken from a representative sample (approximately 3-5 fish per 10 mm size class) of the Brook Trout population at Carlson Lake in 2015 for age and growth analysis (n = 63). We also aged otoliths from a representative sample of the Brook Trout population collected at Carlson Lake in 2006 (n = 81) for comparison. Otoliths were cleaned of debris and mucus, and stored in dry vials. Otoliths were then mounted in epoxy and cross-sectioned using an isometric saw (Beamish 1979, Casselman 1983). Sections were mounted on microscope slides and digitized under 40x magnification. Digital images were read by two independent technicians and, if independent readers were not in agreement on an age, a third reader was used to assign an age to the otolith.

Using the program Fishery Analyses and Modeling Simulator (FAMS) (Slipke and Maceina 2014), we constructed two age-length keys (one from Brook Trout aged in 2006, and one from Brook Trout aged in 2015) in order to determine the proportion of fish of each age, in each length group. Mean length-at-age was then calculated from the age-length keys according the methods outlined in Chapter 16 (Determination of Age and Growth) in Murphy and Willis (1996). To estimate growth rates of the Brook Trout populations for each year (2006 and 2015) we then solved for the von Bertalanffy growth parameters (t_0, k, and L_∞), and constructed growth curves for both years, from age-2 to age-7, for comparison, using the von Bertalanffy growth equation:

$$L_t = L_\infty \left(1 - e^{-k(t-t_0)}\right)$$

where:

L_∞ = maximum theoretical length (length infinity) that can be attained;
k = growth coefficient;
t = time or age in years;
t_0 = time in years when length would theoretically be equal to zero and;
e = exponent for natural logarithms

RESULTS AND DISCUSSION

A total of 200.5 angling hours (combined effort) from June 17 to 21, 2015 was expended to mark 319 Brook Trout (angling CPUE = 1.6 fish/hr). For the recapture event, six gill nets (three sinking and three floating) were set on the evening of June 21 and retrieved the next morning. Gill nets were set for a total of 75 hours (combined effort) and captured 108 Brook Trout (gill netting CPUE = 1.44 fish/hr) (Table 29), 12 of which were recaptures. As a result, the population for 2015 was estimated at 2,682 Brook Trout (95% CI 1,653 – 4,748) (Table 29). Brook Trout caught in gill nets during the recapture event in 2015 ranged in size from 165 mm to 289 mm TL, and averaged 251.7 mm TL (the highest average TL we have observed since monitoring began) (Table 29, Figure 38).

Over the last decade and a half, since tiger muskellunge were first introduced into Carlson Lake, Brook Trout population abundance and size structure has been very dynamic. Following the initial introduction of 41 tiger muskellunge in 2002, the Brook Trout population showed a marked decrease in abundance that was short-lived (Figure 38). By 2006, abundance had increased back to nearly what it had been prior to introduction of tiger muskellunge, so another 32 tiger muskellunge were stocked. Following the second stocking event, another short-lived reduction in the abundance of Brook Trout was observed, but by 2013 we estimated Brook Trout abundance was the highest it had been in more than a decade (Figure 38). Tiger muskellunge were stocked for the third time in 2013, at twice the density as previous events (n = 70), and we observed a significant reduction in abundance by 2015 (approximately 75% less). This reduction in abundance has likely led to reduced competition and improved growth and size structure of Brook Trout in 2015.

Age and growth information from 2006 and 2015 further support our theory that competition has been reduced as a result of reduced abundance of Brook Trout since the last tiger muskellunge stocking event. In 2006, when relative abundance was much higher, Brook Trout reached an average length of 157 mm TL by age-2 and 193 mm TL by age-3. In 2015, length at age 2 and 3 increased to 169 mm TL and 213 mm, respectively (Table 30). Improved growth is likely related to reduced densities from increased predation by tiger muskellunge (Figure 39). Even though Brook Trout now seem to reach a larger size more quickly than previously observed, theoretical maximum TL has not increased (Figure 40), but may increase over the next year or two.

Although tiger muskellunge were first stocked in Carlson Lake in 2002 and 2006, the effect of predation on Brook Trout was not markedly pronounced until 2013. This is likely due to a combination of factors. One, we nearly doubled the stocking density of tiger muskellunge in 2013. Koenig et al. (2015) found that high mountain lake Brook Trout populations could be significantly reduced or even completely eliminated, in some cases, by stocking tiger muskellunge at a density of 40 fish/ha. The first two stocking events in Carlson Lake were at lower densities (20 fish/ha and 16 fish/ha, respectively), but we stocked at 35 fish/ha in 2013.

Secondly, fisheries staff observed at least a dozen tiger muskellunge at the lake in 2015 and, contrary to what was suggested in 2013 (Messner et al. 2015), observed several size/age classes of tiger muskellunge. If this holds true, with a relative reduction in younger age classes of Brook Trout and increased growth rates for those younger age classes as a result, we hope to see an overall increase in maximum size of Brook Trout over the next several years in Carlson Lake (Figure 41). Annual sampling over the next several years should provide insight on whether other factors, besides overabundance and competition, are influencing maximum size potential of Brook Trout in the lake.

MANAGEMENT RECOMMENDATIONS

1. Monitor relative abundance and size structure of Brook Trout periodically over the next several years to determine when/if additional tiger muskellunge stocking is needed to improve Brook Trout size.

Table 29. Summary of estimated abundance and size structure values from survey results at Carlson Lake, 1997 to 2015.

	Abundance				Size structure		
Year	Gill net hours	# fish caught	Relative abundance (CPUE)	Estimated abundance (mark/recapture)	Mean TL (mm) (±SE)	Maximum TL (mm)	Mean W_r (±SE)
1997	466.4	999	2.14	--	192.0 (--)	245.0	--
1998	483.3	818	1.69	--	196.0 (--)	295.0	--
1999	386.1	1,151	2.98	--	198.0 (--)	305.0	--
2000	270.9	665	2.45	--	191.2 (1.4)	270.0	--
2002	147.8	546	3.69	9,024 (95% CI = 7,474-11,064)	200.6 (1.4)	276.1	84.2 (3.1)
2003	416.9	562	1.35	9,063 (95% CI = 6,987-12,039)	209.3 (1.4)	270.0	64.9 (3.3)
2004[a]	40.5	47	1.16	--	225.4 (2.4)	255.0	83.2 (2.1)
2005	369.5	607	1.62	6,103 (95% CI = 4,196-9,262)	230.7 (2.2)	290.0	89.2 (0.9)
2006	64.8	154	2.32	--	215.7 (4.0)	301.0	104.1 (1.3)
2008[b]	20.5	67	3.27	--	224.5 (3.6)	270.0	88.1 (1.5)
2009	151.7	251	1.62	--	233.8 (1.9)	312.0	87.2 (1.0)
2011	132.7	287	2.16	--	218.4 (2.0)	291.0	89.1 (5.1)
2013	172.5	825	4.78	10,867 (95% CI = 9,182-13,008)	220.3 (1.1)	292.0	74.8 (0.3)
2014[b]	3.5	35	10.00	--	226.0 (0.9)	287.0	79.7 (0.4)
2015	75.0	108	1.44	2,682 (95% CI = 1,653-4,748)	251.7 (2.4)	289.0	86.0 (0.8)

[a] hoop net/angling survey
[b] angling surveys

Table 30. Mean length-at-age for Brook Trout sampled at Carlson Lake in 2006 and 2015, calculated from an age-length key from each year, according to methods outlined in Murphy and Willis (1996).

	mean TL (mm)	
Age	2006	2015
2	157.0	168.3
3	193.2	213.3
4	245.0	251.4
5	270.0	270.0
6	261.7	255.0
7	265.0	275.0

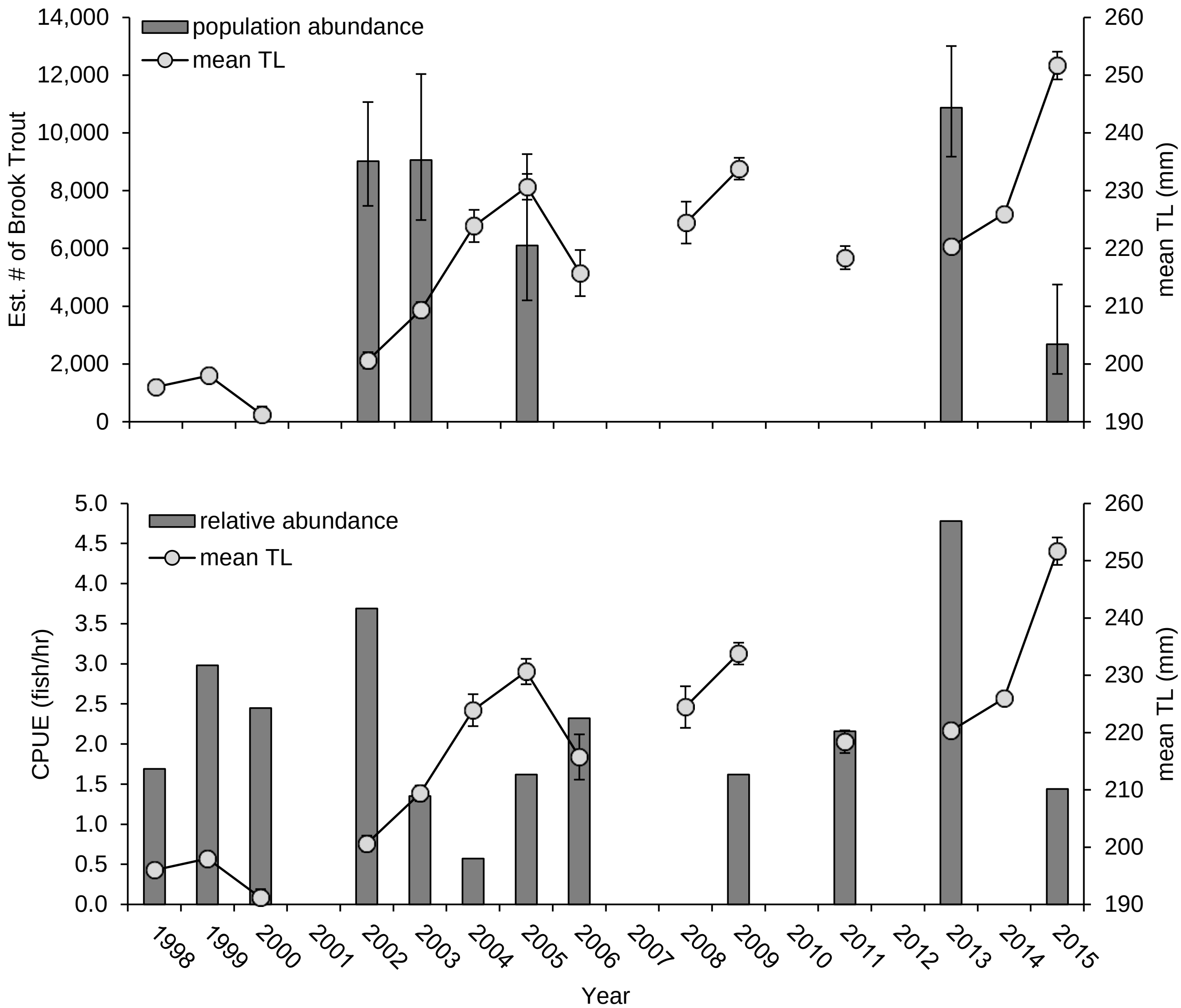

Figure 38. Estimated abundance and size structure of Brook Trout sampled at Carlson Lake, 1998 to 2015. All CPUE values were derived from gill netting surveys, with the exception of 2004 (hoop nets and angling), 2008 (angling), and 2013 (angling). Error bars for estimated population abundance represent 95% confidence intervals, and error bars on mean TL estimates are standard error.

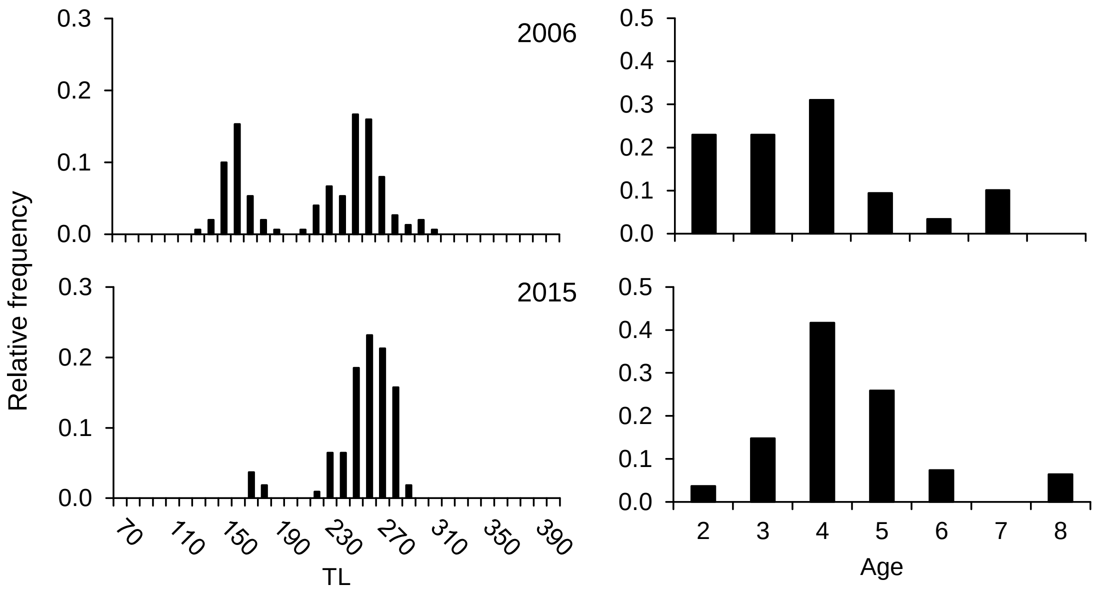

Figure 39. Relative frequency of total lengths (left) and ages (right) for Brook Trout sampled at Carlson Lake in 2006 (n=63) and 2015 (n=81).

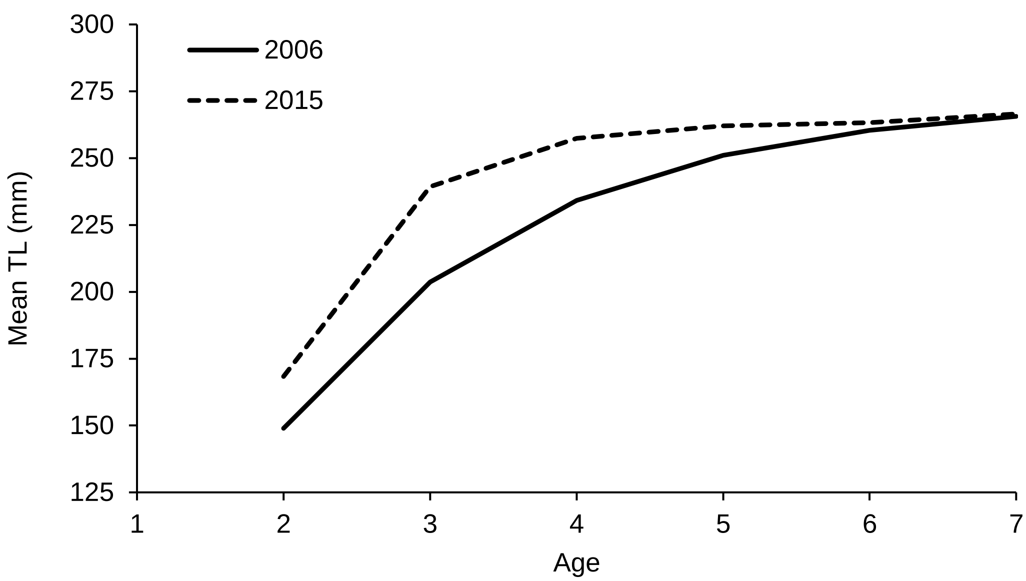

Figure 40. Von Bertalanffy growth curves illustrating differences in Brook Trout growth in Carlson Lake between 2006 (when abundance was high) and 2015 (when abundance was much lower). Values used to construct the growth curves were calculated in FAMS (Slipke and Maceina 2014) (2006: t_0 = 0.652, k = 0.588, and L_∞ = 272.132) and (2015: t_0 = 1.255, k = 1.366, and L_∞ = 270.62).

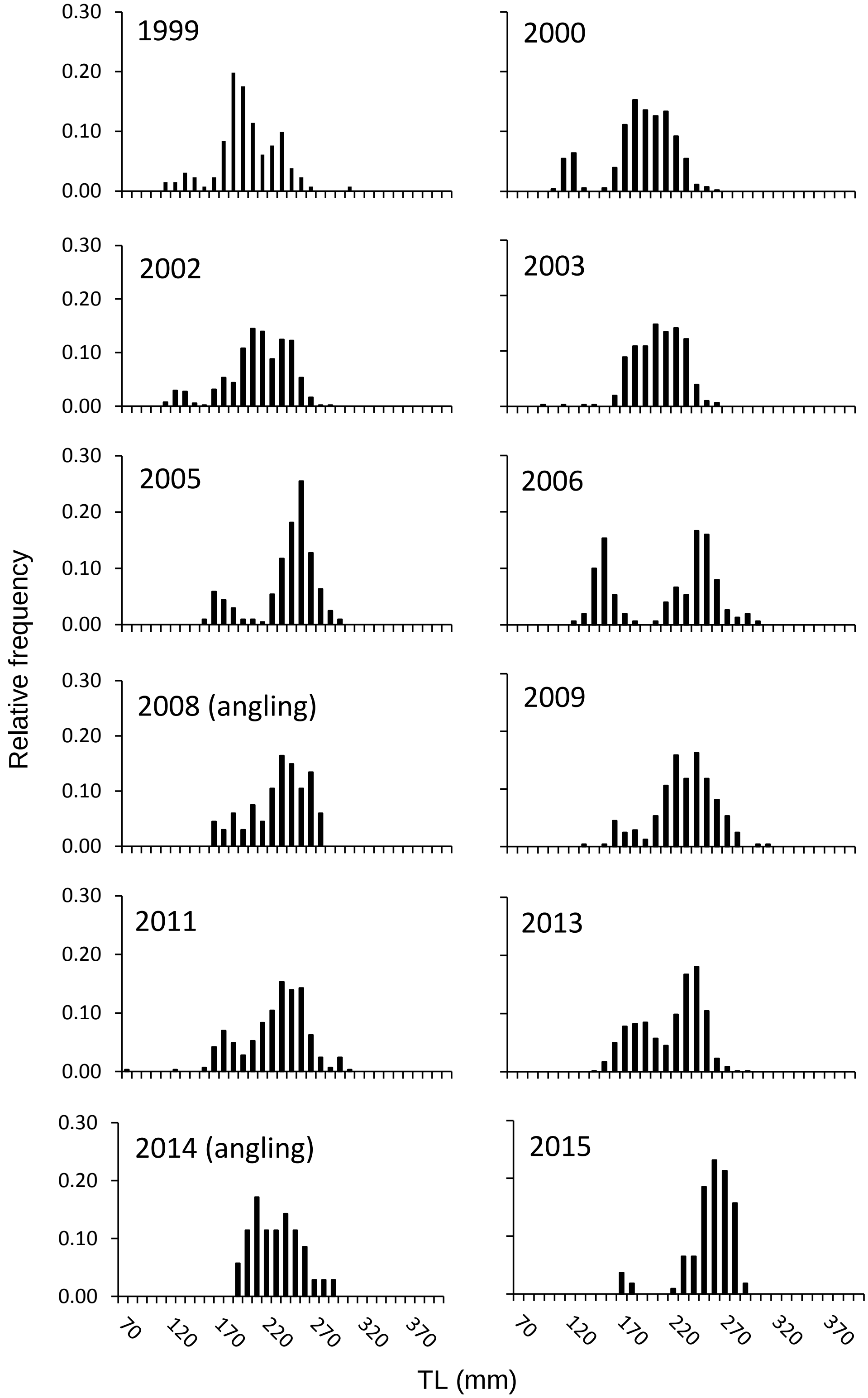

Figure 41. Relative frequency of total lengths of Brook Trout captured at Carlson Lake during gill netting and angling sampling events from 1999 to 2015. Tiger muskellunge were stocked in 2002, 2006, and 2013.

RIVERS AND STREAMS:

SALMON RIVER ELECTROFISHING SURVEYS

ABSTRACT

We used boat electrofishing equipment mounted on a raft and a drift boat to determine trout population composition, abundance, distribution, and size structure in two sections of the mainstem Salmon River in fall, 2015. In the Pennal Gulch to Watt's Bridge section, we captured 148 trout, composed of 46.9% Rainbow Trout (n = 70), 31.3% Westslope Cutthroat Trout (n = 46), 10.9% Westslope Cutthroat Trout x Rainbow Trout hybrids (n = 16), 8.2% Bull Trout (n = 12), and 2.7% Eastern Brook Trout x Bull Trout hybrids (n = 4). Overall trout density was estimated at 62.9 trout/km (95% C.I. 29.6 – 277.1). In the East Fork to Deadman's section we captured 216 trout, composed of 44.9% Rainbow Trout (n = 97), 39.8% Westslope Cutthroat Trout (n = 86), 10.2% Bull Trout (n = 22), 2.8% Westslope Cutthroat Trout x Rainbow Trout hybrids (n = 6), and 2.3% Eastern Brook Trout x Bull Trout hybrids (n = 5). Overall trout density was estimated at 86.2 trout/km (95% C.I. 35.8 – 179.5) in that section. The information gathered in 2015 will serve as baseline information for further studies on the upper mainstem Salmon River.

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INTRODUCTION

The upper Salmon River already serves as a popular fishery for targeting anadromous Chinook Salmon *Oncorhychus tshawytscha* and Steelhead *Oncorhychus mykiss*, but is perhaps under-utilized as a trout fishery. IDFG's current fisheries management plan lists "Improv[ing] the quality of resident trout fishing in the mainstem Salmon River during the summer months" as an objective (IDFG 2014). Our ability to improve trout fishing on the upper Salmon River is hindered by the fact that we currently know little about composition, abundance, distribution, and size structure of trout presently in the river.

The Salmon River supports a wide range of fish species, including anadromous Salmon and Steelhead, Rainbow Trout *Oncorhychus mykiss*, Cutthroat Trout *Oncorhychus clarkii*, Bull Trout *Salvelinus confluentus*, Brook Trout *S. fontinalis*, Mountain Whitefish *Prosopium williamsoni*, Northern Pikeminnow *Ptycheilus oregonensis*, various sucker species *Catastomus* spp., dace *Rhinichthys* spp., sculpin *Cottus* spp., Chiselmouth Chub *Acrocheilus* alutaceus, and Redside Shiners *Richardsonius balteatus*. The last (and only) electrofishing survey conducted on the upper mainstem Salmon River (on four transects in 1998) found that suckers and Mountain Whitefish (combined) made up 67% to 89% of the catch, while trout made up only 1% to 4% (Curet et al. 2000a).

There are certainly opportunities for trout fishing in the upper Salmon River, especially during certain times of the year. Spatial distribution of resident trout throughout the upper mainstem Salmon River varies seasonally, and is likely related to seasonal habits and requirements for each species (i.e. spawning, foraging, and overwintering) (Schoby 2006). Rainbow Trout and Westslope Cutthroat Trout mainly spawn in smaller tributaries in the spring, but occupy various parts of the mainstem river at other times of the year. Bull Trout use the mainstem river for overwintering and foraging during fall, winter, and spring, but aggregate in the upper reaches of smaller tributaries for spawning from mid-summer to early fall (Schoby 2006).

With little information regarding the abundance and size structure of resident trout in the upper mainstem Salmon River, it is difficult to make informed management decisions to improve the quality of resident trout fishing. Baseline information that includes fish densities, species composition, and size structure information will help us identify reaches within the Salmon River that currently offer quality resident trout angling opportunities, and those in need of improvement. Establishing trend reaches and annual sampling will allow us to monitor long-term trends of resident salmonid populations, and evaluate the effectiveness of future management decisions aimed at improving fishing in the basin.

STUDY AREA AND METHODS

We established two trend monitoring reaches in the upper mainstem Salmon River in 2015: East Fork (Salmon River) to Deadman's Hole (Figure 42) and Pennal Gulch to Watt's Bridge (Figure 43) (Table 31). Both sites were visited three times in October, 2015 to conduct a mark/recapture abundance estimate for trout, and determine trout size structure. Trout were marked on the East Fork to Deadman's Hole section October 6 and 8, and recaptured October

14, and trout were marked on the Pennal Gulch to Watt's Bridge section October 7 and 9, and recaptured October 15.

Each of the two trend transect reaches were sampled using direct-current (DC) electrofishing equipment (Infinity by Midwest Electrofishing Systems powered by Honda 5000 W generator) mounted in two boats (raft and drift boat) that operated in tandem through each reach, with one netter on each (Schoby et al. 2013). Pulsed DC current was applied to the water using two booms with Wisconsin ring anodes for the raft and two booms with a single dangle-type anode for the drift boat, at 200-350 volts, 60 hertz, and 25% duty cycle. For the last pass on the Pennal Gulch to Watt's Bridge transect, the anode types were switched between boats. The boat hull served as the cathode for the drift boat and two dangle-type cathodes were used for the raft. Only salmonids were targeted for capture (except whitefish), and only trout were anaesthetized and marked. All trout captured were anaesthetized using MS-222, identified, scanned for PIT tags and other tags/marks, measured (mm TL), and weighed (g). Any *O. mykiss* smaller than 300 mm TL was considered a juvenile Steelhead. All juvenile Chinook Salmon captured were also scanned for PIT tags before release. Any fish that scanned positive for a PIT tag was measured, weighed, and recorded, and that information was entered into P3 for upload to the ptagis website. Trout measuring greater than 150 mm TL were marked by hole-punching the upper caudal lobe on the first pass, and the lower caudal lobe on the second pass. Trout abundance estimates were calculated for all three species combined for each reach, due to insufficient number of recaptures for estimating individual species abundances. We used the Schnabel estimator (multiple mark/recapture technique) to estimate trout abundance in each section using the formula:

$$\hat{N} = \frac{\sum(C_t M_t)}{\sum R_t + 1}$$

where C_t = number of fish captured during pass t, M_t = number of fish marked during pass *t*, and R_t = number of fish recaptured during pass *t*.

Confidence intervals (95%) were calculated using confidence limits for a Poisson distribution because the total number of recaptures was <50 in each section (Krebs, 1989):

$$95\% \text{ confidence limits on } \hat{N} = \frac{(M)(C)}{x+1} - 1$$

where *M* = total number of fish marked, *C* = total number of fish captured during recapture events, and *x* = value obtained from Table 32.

We built length-frequency histograms for each species of trout in each section to describe overall size structure, using all fish captured (including those <150 mm TL), and we calculated proportional stock density for each species of trout using minimum stock and quality lengths described by Gabelhouse (1984) (220 mm TL and 330 mm TL, respectively).

OBJECTIVES

1. Establish trend monitoring sites on the upper mainstem Salmon River and collect baseline information relating to trout abundance and size structure.

RESULTS AND DISCUSSION

For all three days of electrofishing combined, we captured 216 trout in the East Fork to Deadman's section, comprised of 44.9% Rainbow Trout/Steelhead (n = 97), 39.8% Westslope Cutthroat Trout (n = 86), 10.2% Bull Trout (n=22), 2.8% Westslope Cutthroat Trout x Rainbow Trout hybrids (n = 6), and 2.3% Eastern Brook Trout x Bull Trout hybrids (n = 5) (Table 33). We also captured 384 juvenile Chinook Salmon, one of which was PIT tagged on September 1, 2015 at the East Fork Salmon River screw trap (Table 34). Overall trout density (± 95% CI) was estimated at 86.2 trout/km (35.8 – 179.5) (Table 35). Size distributions for all trout captured are shown in Figure 44. Proportional stock density indices for Rainbow Trout and Westslope Cutthroat Trout was 0.03 and 0.40, respectively.

In the Pennal Gulch to Watt's Bridge section, we captured 148 trout, comprised of 46.9% Rainbow Trout/Steelhead (n=70), 31.3% Westslope Cutthroat Trout (n=46), 10.9% Westslope Cutthroat Trout x Rainbow Trout hybrids (n=16), 8.2% Bull Trout (n=12), and 2.7% Eastern Brook Trout x Bull Trout hybrids (n=4) (Table 33). We also captured 83 juvenile Chinook Salmon. Overall trout density was estimated at 62.9 trout/km (95% C.I. 29.6 – 277.1) (Table 35). Size distributions for all trout captured are shown in Figure 45. Proportional stock density indices for Rainbow Trout and Westslope Cutthroat Trout was 0.12 and 0.48, respectively.

Overall, size distributions and species compositions between the two transects were fairly similar (Figures 44 and 45), but catch rates were higher in the East Fork to Deadman's transect (Table 33). We caught more and larger Bull Trout and Westslope Cutthroat Trout in the East Fork to Deadman's transect, but we caught larger Rainbow Trout in the Pennal Gulch to Watt's Bridge transect (Figures 44 and 45). We captured two Bull Trout, one juvenile Steelhead, and one Westslope Cutthroat Trout that had been previously PIT tagged prior to our capture (Table 34).

Electrofishing catch rates in 2015 decreased throughout our survey period in both transects with the exception of drift boat catch rates in the lower transect (Figure 46), likely because anodes were switched for that survey, which slightly improved efficiency. This suggests that for our surveys, the Wisconsin-style anodes were more effective than the single dangle-type anode. We also found that the raft setup was more effective for our needs, because the drift boat was not as easily able to navigate through shallow water and target small pools as well as the raft, which may explain more of the observed discrepancies in catch rates between the two boats. We believe one of the reasons catch rates decreased on sequential passes was because we are conducting our surveys during a time which fish are emigrating downstream to overwintering locations (Schoby 2006), and therefore may emigrate out of our transects. However, we are unfortunately limited to conducting our surveys during this narrow time frame due to permitting constraints to minimize impacts to ESA listed fish species (i.e. Steelhead and Chinook Salmon). To determine how much movement is occurring by resident salmonids during this time period, we may adopt the use of radio telemetry tags for a subsample of captured resident salmonids during future surveys.

Although this is not the first year electrofishing surveys have been conducted in the mainstem Salmon River (initial surveys were conducted in 1998), these surveys are the most extensive. Similar surveys in 1998 (Curet et al. 2000a) were conducted on much shorter transects (mean = 1.5 km), as single-pass surveys performed by a single boat. The information we gathered on trout composition, abundance, and size structure in these two transects in 2015 will therefore serve as baseline information for further annual surveys on the upper mainstem Salmon River. We plan to add several more trend transect reaches to our survey program, and continually monitor these sites to help us prioritize what management efforts could be applied to which areas, to improve resident trout fishing on the upper Salmon River. This information will then also help us determine the effectiveness of those management efforts.

MANAGEMENT RECOMMENDATIONS

1. Continue development of mainstem Salmon River electrofishing trend monitoring sites, and survey protocols as necessary.

2. Annually sample mainstem Salmon River electrofishing sites to study long-term trends in abundance for resident salmonid species.

3. Continue improvement of electrofishing gear, methods, and survey protocol to minimize stress to fish, while maximizing sampling efficiency to produce tighter abundance estimates.

4. Mark resident salmonids with PIT tags in future years to get recapture information across multiple years, and take advantage of multiple PIT tag antenna arrays throughout the Salmon River basin to learn more detailed life history information about resident trout.

Table 31. Upper mainstem Salmon River electrofishing trend transect descriptions.

Section	Start		End		Length (km)	Mean width (m)
East Fork to Deadman's	44.26635°N	114.32729°W	44.34514°N	114.27003°W	12.2	51.5
Pennal Gulch to Watt's Bridge	44.54508°N	114.17904°W	44.6319°N	114.14538°W	12.7	39.9

Table 32. Values (*x*) used to calculate confidence limits for a Poisson frequency distribution with total number of recaptures (R) equaling 0 through 4.

	95 %	
R	Lower	Upper
0	0	3.285
1	0.051	5.323
2	0.355	6.686
3	0.818	8.102
4	1.366	9.598

Table 33. Trout composition and catch-per-unit-effort (CPUE, fish/hr) from electrofishing surveys on the upper mainstem Salmon River in 2015. Species abbreviations are WCT = Westslope Cutthroat Trout, RBT = Rainbow Trout, BUT = Bull Trout, and EBT = Eastern Brook Trout.

		# caught						CPUE					
Section	Hours fished	WCT	WCTx RBT	RBT	BUT	EBTx BUT	Total	WCT	WCTx RBT	RBT	BUT	EBTx BUT	Total
East Fork to Deadman's	15.3	86	6	97	22	5	216	5.62	0.39	6.34	1.44	0.33	14.12
Pennal Gulch to Watt's Bridge	15.5	46	16	70	12	4	148	2.97	1.03	4.52	0.77	0.26	9.55

Table 34. Salmonids captured during mainstem Salmon River electrofishing surveys in 2015, that had been previously PIT tagged in other areas of the Upper Salmon River basin. Information includes location and date of first tagging event, number of subsequent recaptures prior to our 2015 study, and location and date of recapture during mainstem electrofishing in 2015.

		Initial tagging data					*Recapture data*			
PIT ID	Species	Date	Location	TL (mm)	Wt (g)	# recaps	Date	Section	TL (mm)	Wt (g)
3DD.007772FD75	CHN	9/1/2015	EFSR	95	--	0	10/6/2015	EF to Dead	95	9
3DD.00773F3E0C	RBT	4/10/2015	EFSR	--	--	0	10/8/2015	EF to Dead	298	253
3D9.1C2DF68426	WCT	7/20/2013	YFSR	205	94	0	10/8/2015	EF to Dead	370	492
3D9.1BF25D3BE0	BUL	6/20/2011	EFSR	429	--	1	10/9/2015	Pen to Wat	571	1746
3D9.1BF24313BD	BUL	6/15/2012	EFSR	515	--	2	10/14/2015	EF to Dead	631	2414

Table 35. Number of trout marked (M), captured (C), and recaptured (R) during each of the three passes on each section of the upper mainstem Salmon River in 2015. Also shown are Schnabel abundance estimates calculated using M, C, & R numbers.

	1st pass	2nd pass			3rd pass				
Section	M	C	R	M	C	R	Distance (km)	Trout/km	95% CI
East Fork to Deadman's	88	95	2	93	25	3	12.2	86.2	(35.8-179.5)
Pennal Gulch to Watt's Bridge	74	51	4	47	31	4	12.7	62.9	(29.6-277.1)

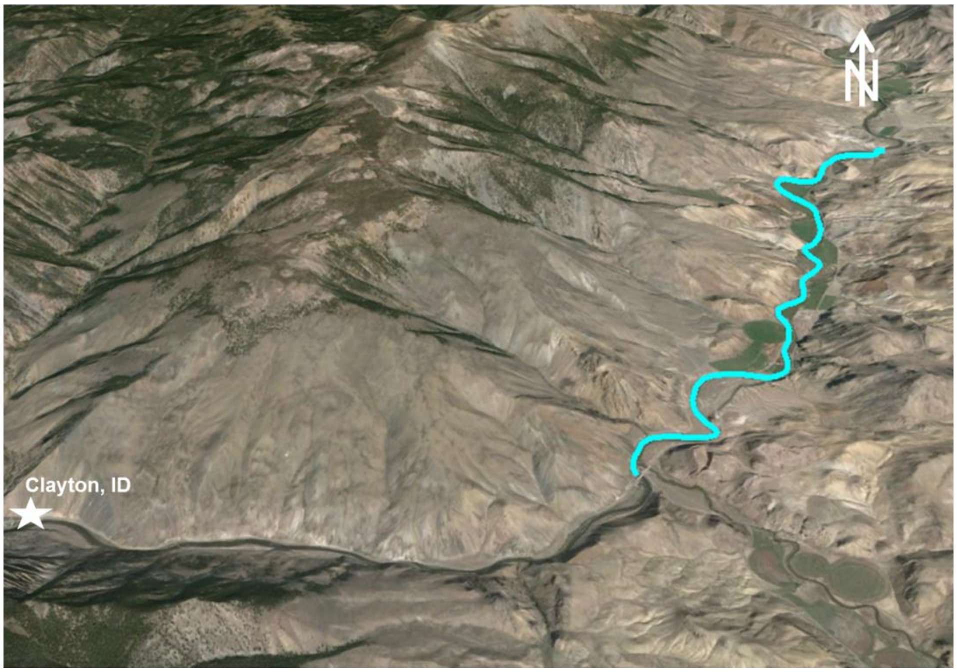

Figure 42. East Fork to Deadman's trend transect on the upper mainstem Salmon River, established in 2015.

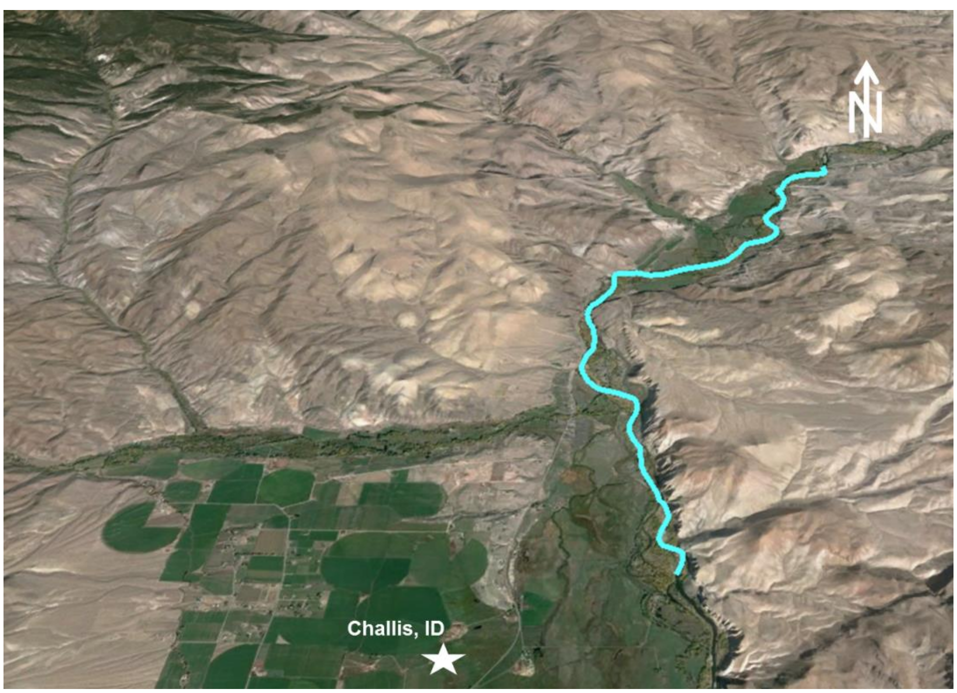

Figure 43. Pennal Gulch to Watt's Bridge trend transect on the upper mainstem Salmon River, established in 2015.

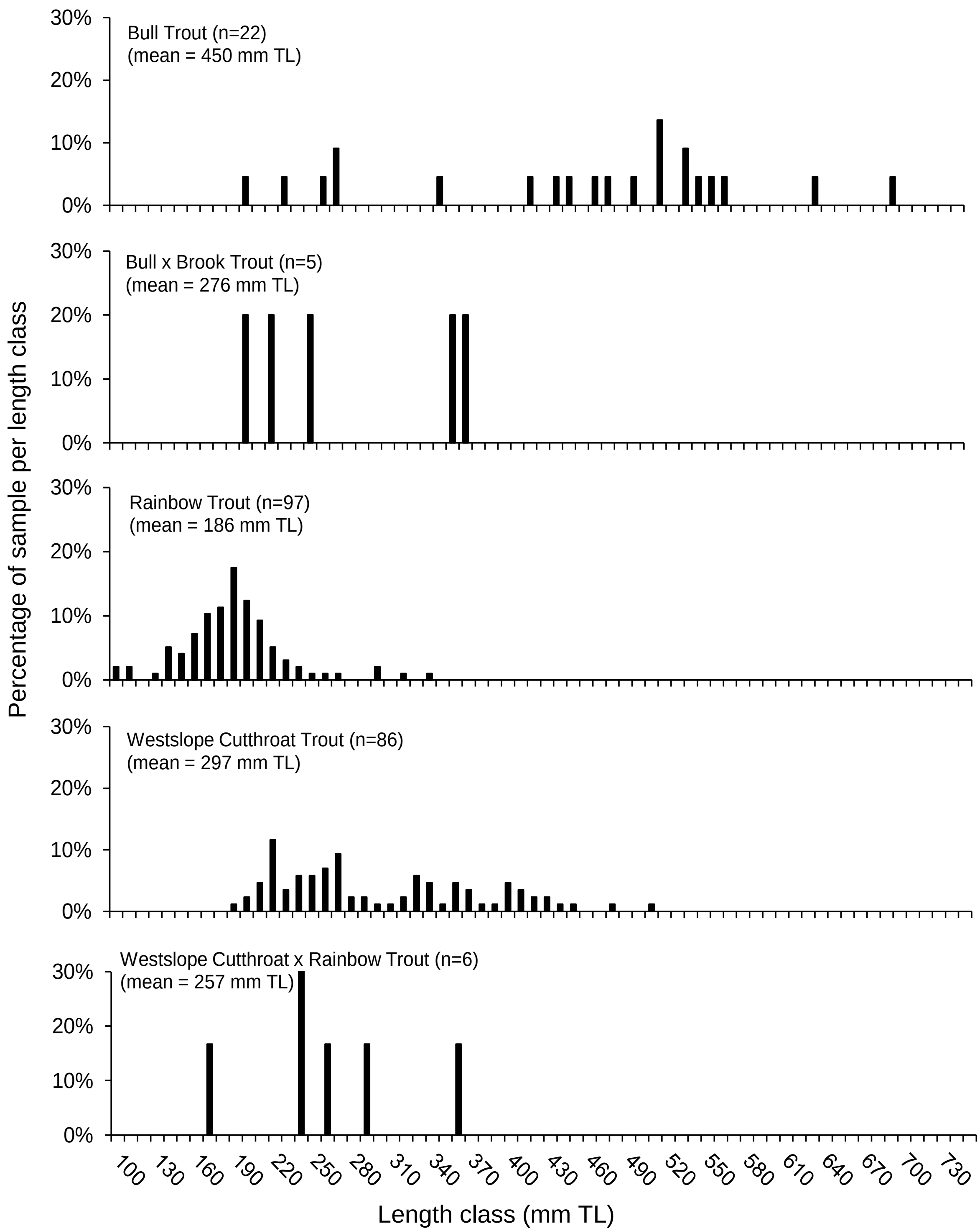

Figure 44. Length-frequency histograms for each species (and hybrids) of trout captured in the East Fork to Deadman's transect on the upper mainstem Salmon River, 2015.

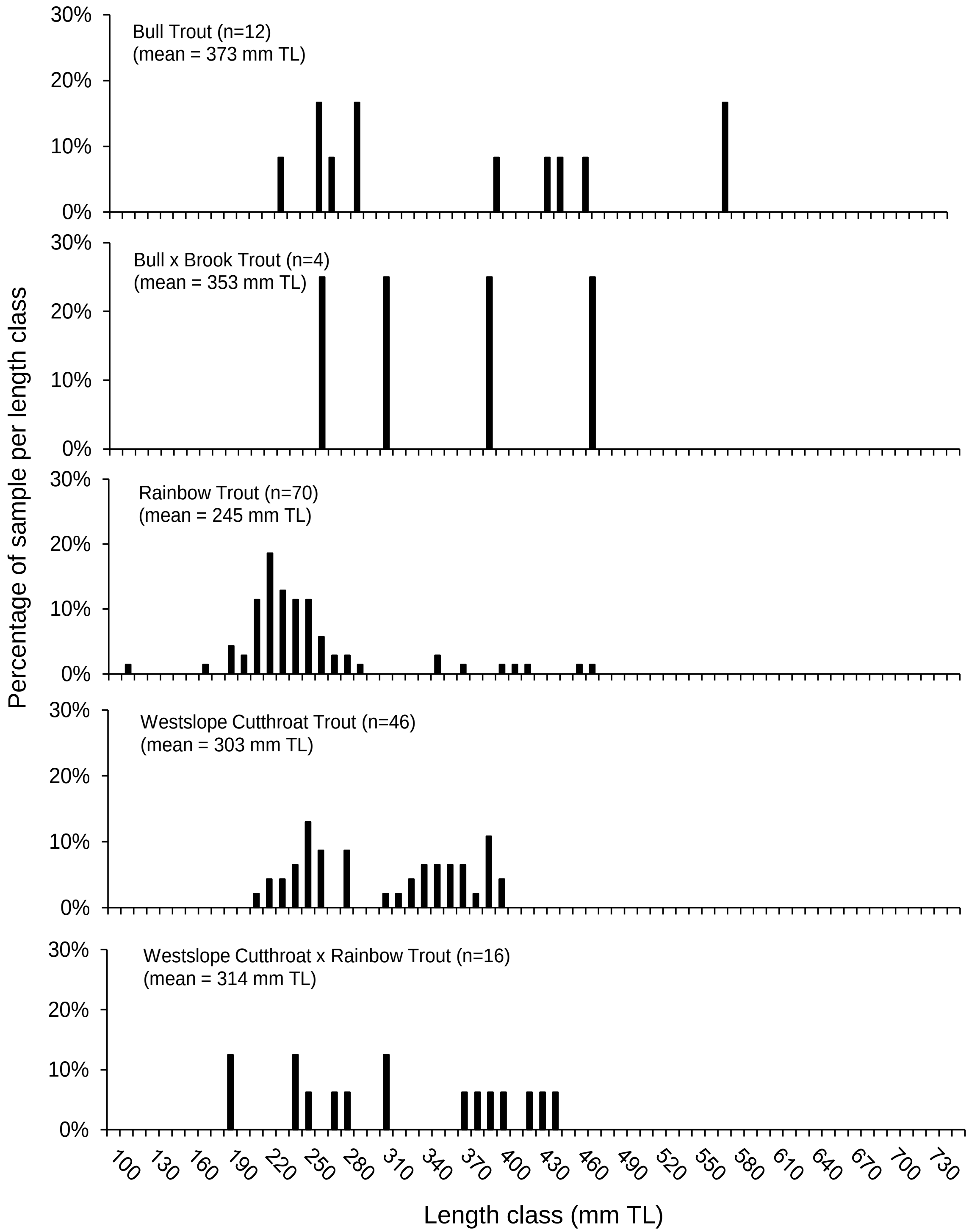

Figure 45. Length-frequency histograms for each species (and hybrids) of trout captured in the Pennal Gulch to Watt's Bridge transect on the upper mainstem Salmon River, 2015.

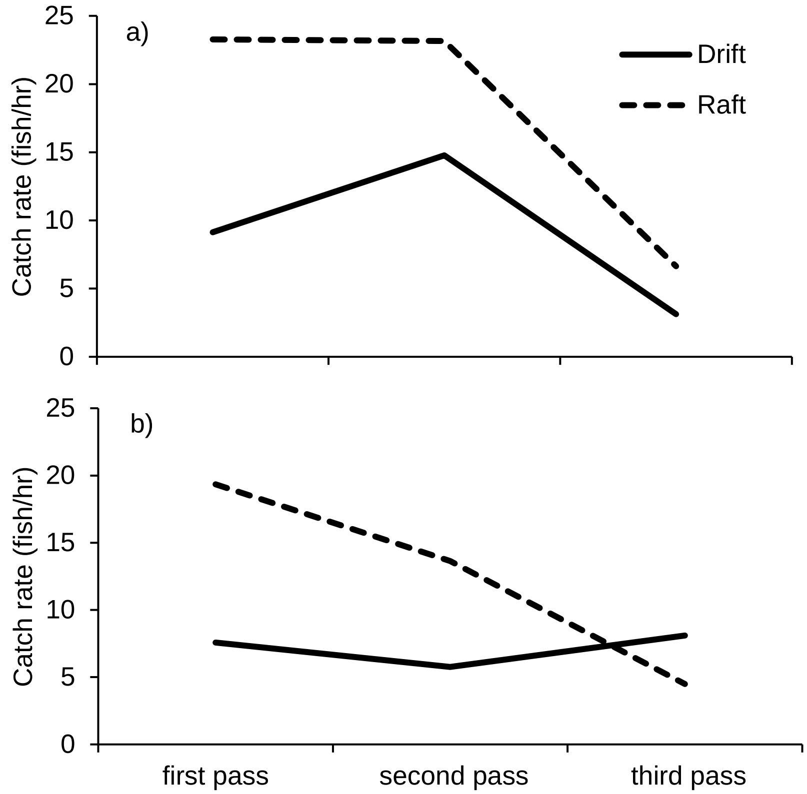

Figure 46. Catch rates (fish/hr) (trout only) for the East Fork to Deadman's (a) and Pennal Gulch to Watt's Bridge (b) sections, during all three passes, sorted by boat type (drift boat and raft) in 2015.

RIVERS AND STREAMS:

RAINBOW TROUT CHEEK MUSCLE PIT TAG RETENTION

ABSTRACT

In February, 2015 we implanted PIT tags in the cheek muscle of hatchery Rainbow Trout *Oncorhynchus mykiss* (250 – 310 mm TL) at Mackay Fish Hatchery to examine retention rates, and evaluate the use of this tagging location as a potential alternative to the body cavity location we currently use. Twenty fish were implanted with 8.5 mm tags and 20 fish with 12 mm tags, and retention rates were monitored after one month and two months at the hatchery. After one month, 75% (n = 15) of the fish implanted with 8.5 mm tags had retained their tag, and 65% (n = 13) of the fish implanted with 12 mm tags had retained their tag. For both tag sizes, 85% of the fish that retained their tag after the first month, also retained their tag after the second month. Overall, after the two-month study period, 63% (n = 12) of the 8.5 mm tags were retained and 55% (n = 11) of the 12 mm tags were retained. Based on these results, we feel that the body cavity is a more dependable tagging location for smaller (<300 mm) Rainbow and Cutthroat Trout in the upper Salmon River basin, unless methods can be improved to produce higher cheek tagging retention rates.

Author:

Jordan Messner, Regional Fisheries Biologist

INTRODUCTION

For fish movement and migration studies in stream systems that have Passive Integrated Transponder (PIT) array infrastructure in place (ex. the Upper Salmon River basin), PIT tagging can provide an abundance of useful information. PIT tags are long lived, provide a unique identifier for each fish, and are valued for a wide range of uses. In these systems, PIT tags, unlike any other tagging method, allow biologists to examine fish movement and migration timing with minimal field effort (i.e. no field effort after initial tagging). Once fish are initially captured and implanted with a PIT tag, interrogations at PIT arrays are logged in real-time and stored in the Ptagis database (www.ptagis.org) for later analysis.

PIT tag retention rates can vary by body location, fish size, and sex/sexual maturity (Meyer et al. 2015). Common locations for PIT tag implantation in trout are the body cavity, dorsal musculature, and cleithrum (posterior to operculum). Mamer and Meyer (Meyer et al 2015) found that, although PIT tags injected into the body cavity in trout <200 mm in length were retained at a rate of 100%, retention rate for body cavity tagging in larger trout was much lower and varied by sex (89% and 59% for males and females, respectively), likely due to expelling tags during spawning. In that study, both cleithrum and dorsal musculature tagging locations showed higher retention rates (84% and 93%, respectively). However, PIT tags recovered from approximately half of the fish implanted in either of these two locations were found in the muscle tissue of fillets, which may become an issue for anglers if fish are harvested.

When PIT tagging fish for movement and migration studies in streams where angler harvest is permitted, tags contained within fillets is a major concern. PIT tags contain glass and metal components, which could be harmful to anglers if consumed. In those systems, body cavity tagging is likely the best option to avoid human consumption. In 2015, we explored the viability of implanting PIT tags in the cheek muscle of small (250-300 mm TL) Rainbow Trout *Oncorhynchus mykiss*. Cheek muscle tags will not be consumed in fillets, and may be a valid alternative to the aforementioned tagging locations if they are retained well. Although the cheek muscle is already a common PIT tagging location for larger fish (ex. Muskellunge), and retention rates have proven to be as high as 92% over the course of a year (Younk et al. 2010), its utility for small stream-dwelling trout has not been extensively studied. Our objective in 2015 was to assess retention rates for 8.5 mm and 12 mm PIT tags implanted into the cheek muscle of smaller Rainbow Trout (250-300 mm TL), to determine whether this method could be used for tagging fish in the Upper Salmon River basin, where there is currently a large number of PIT array antennas in place, and angler harvest may occur in select locations and times.

METHODS

On February 3, 2015 we implanted PIT tags in the cheek muscle of 40 Rainbow Trout at the Mackay Fish Hatchery to assess retention rates and explore this as a potential alternative to body cavity and dorsal musculature tagging locations. Hatchery Rainbow Trout implanted with PIT tags ranged between 250 mm and 310 mm TL. To determine the best cheek tagging location, we first implanted 12 mm PIT tags into deceased hatchery Rainbow Trout and subjectively assessed their likelihood of retention. Once we felt comfortable with our tagging methods and location, we injected 8.5 mm PIT tags into 50% of the live fish (n = 20) and 12 mm PIT tags into the other 50% (n = 20). Fish implanted with 12 mm tags were also given a caudal punch as a secondary mark, to differentiate tag retention by tag size.

PIT tags were implanted at the posterior end of the cheek muscle, in line with the lower edge of the eye (Figure 47A and B). To prevent the PIT tag from being pushed too far into the tissue, we removed the needle from the cheek muscle at the same time the syringe was depressed to deploy the tag. After the tag was deployed, we attempted to replace the flap of skin tissue that was cut during injection, back over the hole left by the syringe, to avoid leaving a visible hole on the fish where the tag could be rejected (Figure 47C and D). Finally, a drop of veterinary adhesive (3M Vetbond™) was applied to the injection site and allowed to cure (approximately 10 seconds) before the fish was returned to the circular tank.

Fish were fed by hatchery staff regularly during our experiment. We assessed tag retention after 1-month and 2-months in the circular tanks. Each fish was scanned with a handheld PIT tag detector, examined for secondary marks, and returned to the tank. We also examined each fish for tagging scars and provided comments on how well the injection site was healed.

RESULTS AND DISCUSSION

After one month, 75% (n=15) of the fish implanted with 8.5 mm tags had retained their tag, and 65% (n = 13) of the fish implanted with 12 mm tags had retained their tag (Figure 48). For both tag sizes, 85% of the fish that retained their tag after the first month, also retained their tag after the second month (Figure 48). Overall, after the two-month study period, 63% (n = 12) of the 8.5 mm tags were retained and 55% (n = 11) of the 12 mm tags were retained (Figure 48).

Although this was our first attempt at cheek tagging, and methods could likely be improved to increase retention rates, we feel that the body cavity is a more dependable tagging location for smaller (<300 mm) trout in the upper Salmon River basin. As Mamer and Meyer reported (Meyer et al. 2015), we can achieve similar retention rates for body cavity tagging even in larger females that may expel their tags during spawning. Our methods can be improved to increase retention rates for cheek tagging smaller trout, but more trials are needed to refine techniques.

During this study, we saw almost 10% higher retention for smaller tags (8.5 mm) implanted into the cheek muscle, suggesting tag size relative to fish size may affect whether the tag is retained. We were unable to determine whether retention varied by fish size, because fish were not measured after the initial tagging event. Our current methods for cheek tagging may be successful in obtaining higher retention rates than body cavity tagging in larger fish (>300 mm). Adult Muskellunge PIT tagged in cheek muscle can show up to 92% retention over several years (Younk et al. 2010), so we may be able to get similar retention rates for large fluvial trout in the upper Salmon River basin. IDFG staff operating the East Fork Salmon River fish weir have been tagging large fluvial Bull Trout (360 mm to 750 mm TL) using the same methods we outlined above, since 2007. Over the past eight years, they have observed retention rates between 85% and 98%, with higher retention rates in more recent years as the technique has been improved (Brian Ayers, IDFG, personal communication). Even though this may be an effective tagging location for large fluvial Bull Trout, since there is currently no angling harvest allowed for Bull Trout in the upper Salmon River basin, we do not see the need to switch to this tagging location, when dorsal musculature tagging can achieve similar retention rates (Meyer et al. 2015). However, this may be a viable tagging location for large fluvial Rainbow and Westslope Cutthroat Trout *O. clarkii lewisi* in the basin, which may be available to harvest by anglers if encountered in certain tributaries during open harvest seasons. More work is needed to determine if modifications to our current methods can achieve higher retention rates for smaller fish, but for the time being we recommend using other tagging locations for these fish.

MANAGEMENT RECOMMENDATIONS

1. Continue using dorsal sinus and body cavity tagging locations until methods are improved to result in higher tag retention for cheek muscle location.

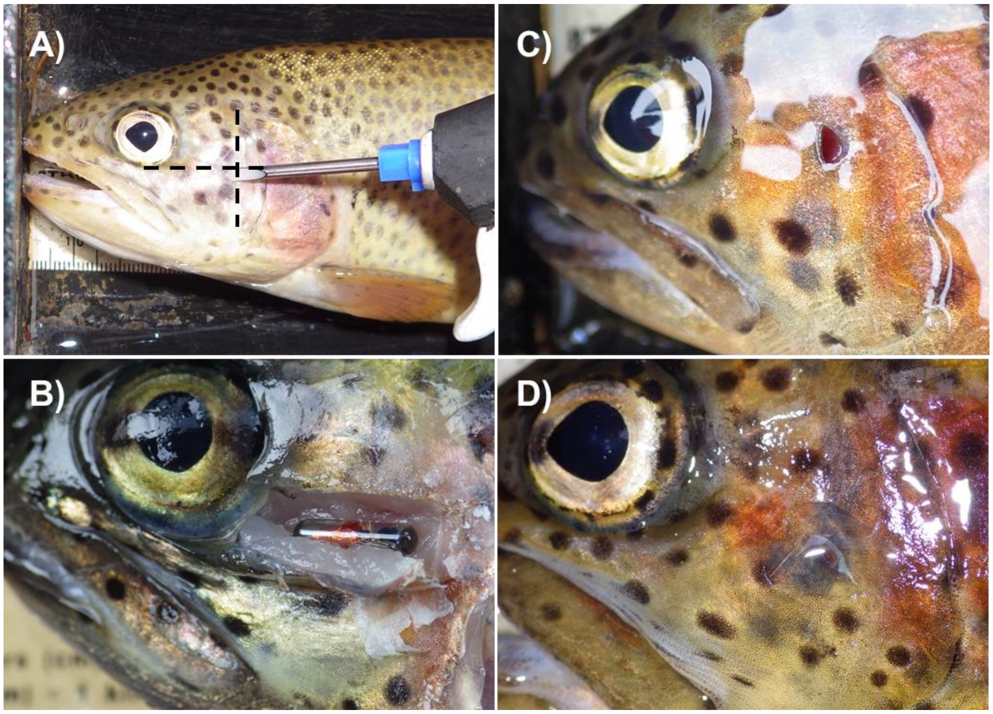

Figure 47. PIT tag insertion into the cheek muscle of hatchery Rainbow Trout. A) target location for the insertion B) location and orientation of PIT tag that was retained throughout the duration of our study C) open hole scar caused by improper insertion D) proper insertion results in no open hole, and the flap of skin can be glued down to seal the insertion.

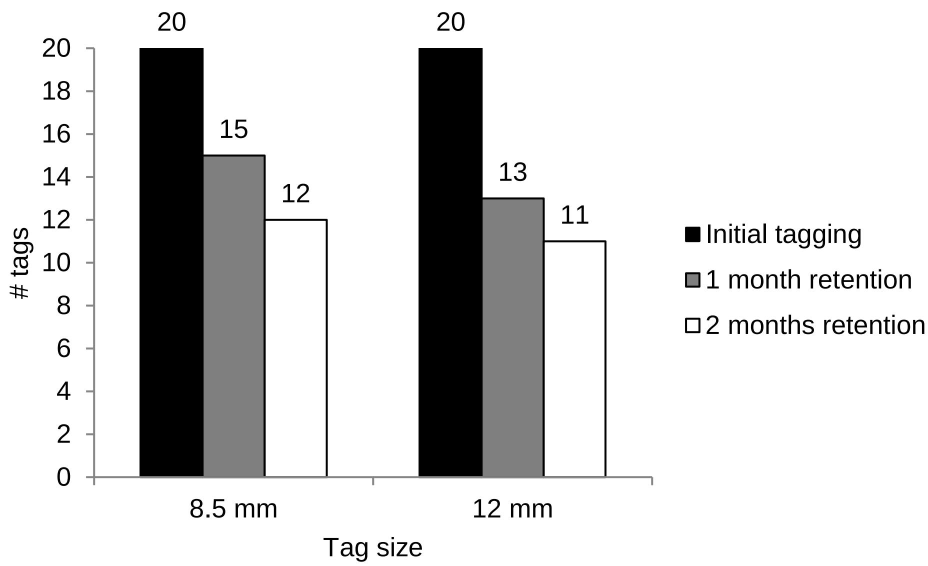

Figure 48. Number of PIT tags, inserted into the cheek muscle of small ($\leq$ 320 mm) Rainbow Trout, retained after one month and two months post-tagging at Mackay Fish Hatchery in 2015.

RIVERS AND STREAMS:

WILD TROUT REDD COUNTS

ABSTRACT

Regional fisheries staff conducted redd count surveys for resident Rainbow Trout *Oncorhynchus mykiss* and Bull Trout *Salvelinus confluentus* populations in 2015, as part of an annual trend monitoring program. In spring, we counted 125 Rainbow Trout redds in Big Springs Creek and 75 in the Lemhi River. During Bull Trout redd count surveys in fall 2015, we counted three redds in Alpine Creek, 63 in Fishhook Creek, 51 in Fourth of July Creek, 137 in Bear Valley Creek, 40 in East Fork Hayden Creek, and 18 redds in the main stem of Hayden Creek. Compared to surveys in 2014, the number of Rainbow Trout redds counted in the Lemhi River and Big Springs Creek in 2015 decreased, and the number of Bull Trout redds counted in 2015 decreased in all transects except Fishhook Creek and East Fork Hayden Creek.

Author:

Jordan Messner, Regional Fisheries Biologist

INTRODUCTION

The Salmon Region conducts annual redd counts for resident and fluvial Rainbow Trout *Oncorhynchus mykiss* and Bull Trout *Salvelinus confluentus* in nine streams in the region, to monitor spawning escapement trends. In 1994, the region began counting Rainbow Trout redds in Big Springs Creek, a tributary to the upper Lemhi River near Leadore, and in 1997 another transect was established for Rainbow Trout on the upper Lemhi River, just above the confluence with Big Springs Creek. Redd count monitoring for Rainbow Trout on these transects provides a general indication of population abundance trends over time. Numerous habitat improvement projects, changes in water-use practices, alterations in land management practices, and fisheries regulation changes have occurred in the upper Lemhi River basin in the last decade, all of which have likely benefited resident fish populations.

Bull Trout were listed as threatened under the Endangered Species Act (ESA) on June 10, 1998. That fall, the region established its first trend transects for enumerating Bull Trout redds. Trend transects were established on Alpine and Fishhook Creeks in the Sawtooth Basin, near Stanley, that year. Trend transects were then established on Bear Valley Creek and East Fork Hayden Creek in the Lemhi River drainage in 2002, on Fourth of July Creek in the Stanley basin in 2003, and on Upper Hayden Creek in the Lemhi River drainage in 2006.

As additional redd production areas have been located (outside of established transect boundaries), new trend transects have been added to encompass as much spawning production as possible. New transects were added to account for additional productivity on Bear Valley Creek in 2007, on Fishhook Creek in 2008, and on Alpine Creek in 2011. In upper Hayden Creek, the trend transect was moved altogether in 2010, when staff determined the existing transect was too low in the drainage and most Bull Trout spawning occurred much higher.

OBJECTIVES

1. Maintain trend monitoring datasets for spawning resident and fluvial trout in the region by continuing annual redd counts and operating fish weirs in priority tributaries.

STUDY AREA AND METHODS

<u>Rainbow Trout Redd Count Monitoring</u>

Big Springs Creek

Big Springs Creek is a tributary to the Lemhi River, located approximately 8 km north of Leadore, Idaho. Two trend transects (Tyler transect and Neibaur transect) are walked on Big Springs Creek annually (Messner et al, *in press* [b]) (Appendix B). The Big Springs transects were the first resident/fluvial Rainbow Trout redd count trend transects established in the region, in 1994.

Redd counts are usually conducted during the last week of April or the first week of May on Big Springs Creek. The counts are “single pass” counts, where redds are counted on a single occasion and are not flagged. Redd counts on Big Springs Creek were conducted on May 5 in 2015.

Lemhi River

The Lemhi River flows approximately 100 km from its headwaters near Leadore, Idaho to its confluence with the Salmon River at Salmon, Idaho. The upper Lemhi River redd count trend transect was established in 1997 and includes a 3 km section of Lemhi River flowing through the property known as the Merrill Beyeler Ranch from the fence line 100 meters upstream of the upper water gap to the lower fenced boundary (Messner et al, *in press* [b]) (Appendix B).

Redd counts are usually conducted during the last week of April or the first week of May, at the same time and using the same methods as for Big Springs Creek (single pass). Redd counts were conducted on May 5, 2015.

Bull Trout Redd Count Monitoring

Alpine Creek

Alpine Creek is a tributary to Alturas Lake Creek, which flows into Alturas Lake in the Sawtooth basin, approximately 35 km south of Stanley, Idaho. Two trend transects are walked annually on Alpine Creek (Messner et al, *in press* [b]) (Appendix B).

Historically, two visual ground counts are conducted annually, about two weeks apart, on both transects in Alpine Creek. However, only one count was conducted in 2015 due to insufficient time for completing both counts. The survey in 2015 was conducted on September 3. For each transect, all redds in progress or completed redds were counted during the survey.

Fishhook Creek

Fishhook Creek is a tributary of Redfish Lake in the Sawtooth basin, approximately 10 km south of Stanley, Idaho. Two trend transects are walked on Fishhook Creek annually (Messner et al, *in press* [b]) (Appendix B).

Historically, two visual ground counts are conducted annually, about two weeks apart, on each of the two Fishhook Creek transects. Only one count was conducted in 2015 due to insufficient time for completing both counts. The survey on Fishhook Creek was conducted on September 3, 2015. For each transect, all redds in progress or completed redds were counted during the survey.

Fourth of July Creek

Fourth of July Creek is a tributary of the upper Salmon River in the Sawtooth basin, located approximately 28 km south of Stanley, Idaho. One single visual ground count is conducted on Fourth of July Creek annually (Messner et al, *in press* [b]) (Appendix B).

Fisheries staff conducted a redd count survey for Bull Trout in Fourth of July Creek on September 9, 2015. Redd counts on Fourth of July Creek are “single pass” counts, meaning redds are enumerated on a single occasion and are not flagged.

Hayden Creek

Hayden Creek is the largest tributary to the Lemhi River. The trend transect currently surveyed on upper Hayden Creek (Appendix B) is not the same that was established in 2006. The older transect produced single digit Bull Trout redd counts each year between 2006 and 2009.In 2010, the transect boundaries were moved upstream to the current location (Messner et al, *in press* [b]) to encompass the bulk of spawning activity (M. Biggs, IDFG, personal communication).

Both fluvial and resident forms of Bull Trout are found in upper Hayden Creek. The upper Hayden Creek trend transect is walked twice annually, approximately one week apart, to visually count fluvial and resident Bull Trout redds. In 2015, three pass counts were conducted. Redd counts in 2015 were conducted on September 9, 14, and 24. Since fluvial Bull Trout are larger in size than residents, fluvial Bull Trout redds were classified as redds equal to or greater than 0.4 m by 0.6 m in diameter while redds smaller in size were considered those of resident Bull Trout. For each transect, all redds in progress or completed redds were counted during the first survey and flagged. On the second survey in each transect, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds

Bear Valley Creek

Bear Valley Creek is a tributary of Hayden Creek in the Lemhi River drainage, located approximately 60 km south of Salmon, Idaho. Two trend transects are walked annually on Bear Valley Creek to enumerate Bull Trout redds (Messner et al, *in press* [b]) (Appendix B).

Two to three visual ground counts are conducted annually about one week apart on the Bear Valley Creek transects. A third pass is only conducted when the ratio of live fish to redds is greater than one on the second pass. In 2015, counts were conducted on September 9, 15, and 22. Both fluvial and resident Bull Trout life histories are found in Bear Valley Creek. Since fluvial Bull Trout are larger in size than residents, fluvial Bull Trout redds were classified as redds equal to or greater than 0.4 m by 0.6 m in diameter while redds that were smaller in size were considered those of resident Bull Trout. For each transect, all redds in progress or completed redds were counted during the first survey and flagged. On the second and third passes in each transect, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds.

East Fork Hayden Creek

East Fork Hayden Creek is a tributary of Hayden Creek in the Lemhi River drainage. The confluence of the East Fork Hayden Creek and Hayden Creek is located approximately 15 km upstream from Hayden Creek's confluence with the Lemhi River. A single-pass redd count is conducted annually on the East Fork Hayden Creek trend transect to enumerate resident Bull Trout redds (Messner et al, *in press* [b]) (Appendix B). Bull Trout that spawn in the East Fork Hayden Creek exhibit a resident life history strategy only (i.e. no fluvial form).

Bull Trout redd counts on East Fork Hayden Creek in 2015 were conducted September 14 and 21. All redds in progress or completed redds were counted during the first survey and flagged. On the second survey, additional completed redds were counted and included with the number of flagged redds to provide a total number of redds.

RESULTS AND DISCUSSION

Rainbow Trout Redd Count Monitoring

Big Springs Creek and Lemhi River

Fisheries staff observed 125 Rainbow Trout redds in Big Springs Creek and 75 Rainbow Trout redds in the upper Lemhi River in 2015, for a total of 200 redds (Table 36, Figure 49). On Big Springs Creek, 65 redds were counted in the historic Neibaur Ranch transect while 60 redds were observed in the Tyler Ranch transect (Table 36). The total number of redds counted in the Lemhi River and Big Springs Creek has fluctuated quite a bit over the last several decades, but was showing an overall increasing trend going into 2014 (Figure 49). In 2015 however, the total number of redds counted fell just below the overall average trend count. The 2012 to 2014 trend counts were three of the four highest counts on record, so the spawning cohort in 2015 may just indicate the presence of a relatively weak age class. Numerous habitat improvement projects, tributary reconnections, and changes in land-use practices over the last several decades in the upper Lemhi River seem to have benefitted the resident Rainbow Trout population. These transects will continue to be monitored annually to assess Rainbow Trout population trends.

Bull Trout Redd Count Monitoring

Alpine Creek

In the upper Alpine Creek trend transect, we counted three Bull Trout redds in 2015 (Table 37, Figure 50). Prior to 2013, no Bull Trout redds, or live fish, had been observed in the upper trend area in five years. Only one redd was counted in the upper transect in 2013, and four redds were counted in 2014. In the lower trend transect (established in 2010), no Bull Trout redds were observed in 2014 or 2015. Not more than two Bull Trout redds have been observed in that reach since the transect was established (Figure 50).

The cause for low numbers of Bull Trout redds observed in Alpine Creek in the last seven years is unknown. From 2000 to 2007, an average of 14.4 redds per year (± 1.8) have been observed in the upper trend transect. In 2014, we questioned whether we were missing spawning activity (geographically or temporally) since we had not observed more than four redds in a given year in Alpine Creek since 2007. In 2015, we walked the entire stream from approximately 2 km above the upper transect, to Alturas Lake. Although we did document some fish activity outside of established transect boundaries, we did not find any evidence that there was a great deal of spawning activity occurring outside of these transect. Further monitoring may help us determine the cause of reduced redd numbers in Alpine Creek over the last seven years.

Fishhook Creek

Sixty-one Bull Trout redds were observed in the upper trend transect in Fishhook Creek in 2015, and 17 redds were counted in the lower transect (Table 37, Figure 51). The quantity of redds observed in the upper transect in 2015 is highest documented to date, and is over twice as many observed in the previous high count in 2001 (n = 26). Prior to 2015, Bull Trout redd numbers in Fishhook Creek have remained relatively consistent over the years, indicating a stable population. However, the number of redds observed in 2015 suggests the presence of a very strong age-class of spawners that has not been documented previously.

Fourth of July Creek

Staff counted 51 completed Bull Trout redds in the Fourth of July Creek trend transect in 2015 (Table 37). Consistent with the previous 12 years of data, a pattern in the trend seems to suggest the presence of four consecutive relatively strong redd counts, followed by a low count every fifth year (Figure 52). The lowest count observed was in 2003, followed by four higher count years in 2004 to 2007, another low count year in 2008, four higher count years from 2009 to 2012, and in 2013 we saw another low year. Consistent with this pattern, 2014 and 2015 were high count years, and based on this, we expect to see an average to above-average number of redds in 2016.

Bear Valley Creek

Regional fisheries staff counted 39 Bull Trout redds in the older Bear Valley Creek trend transect in 2015 and 98 redds in the newer trend transect, for a total of 137 redds (Table 38, Figure 53). In general, Bull Trout spawner abundance has remained stable in Bear Valley Creek over the last 14 years, but has been relatively higher in recent years. Although counts in 2015 are slightly lower than in 2014, the overall trend suggests that spawner abundance is on an increasing trends since the mid- to late-2000's. Redd count surveys will be conducted annually on both trend transects to continue monitoring trends in spawner abundance.

East Fork Hayden Creek

A total of 40 resident Bull Trout redds were observed in the East Fork Hayden Creek trend transect in 2015 (Table 38, Figure 54). This population has remained relatively stable over the past 14 years, ranging from 23 redds to 61 redds per year. The 2015 count represents an average year.

Hayden Creek

Eighteen Bull Trout redds were counted in the upper Hayden Creek trend site in 2015 (Table 38, Figure 55). The 2015 count is one of the lowest counts we have observed in Hayden Creek in the last 11 years.

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring trends in spawner abundance for resident trout populations in designated trend transects.

Table 36. Summary of Rainbow Trout redds counted in the upper Lemhi River and Big Springs Creek (BSC) transects, 1994 - 2015.

Year	Big Springs Creek Neibaur Ranch	Big Springs Creek Tyler Ranch	Lemhi River Beyeler Ranch	Total
1994	--	--	--	40
1995	57	--	--	57
1996	32	--	7	39
1997	44	45	8	97
1998	93	124	18	235
1999	39	71	29	139
2000	160	123	23	306
2001	95	186	2	283
2002	360	193	3	556
2003	128	103	56	287
2004	174	45	15	234
2005	75	43	3	121
2006	63	143	9	215
2007	163	62	8	233
2008	82	108	9	199
2009	100	54	10	164
2010	132	57	18	207
2011	103	49	20	172
2012	130	224	14	368
2013	159	122	49	330
2014	185	280	93	558
2015	65	60	75	200

Table 37. Bull trout redds counted in tributaries of the upper Salmon River in the Sawtooth National Recreation Area, 1998 - 2015.

Stream	Year	Older transect redds	Newer transect redds	Total redds
Alpine Creek	1998	1	--	1
	1999	3	--	3
	2000	9	--	9
	2001	15	--	15
	2002	14	--	14
	2003	14	--	14
	2004	9	--	9
	2005	13	--	13
	2006	13	--	13
	2007	18	--	18
	2008	0	--	0
	2009	0	--	0
	2010	0	1	1
	2011	0	2	2
	2012	0	0	0
	2013	1	2	3
	2014	4	0	4
	2015	3	0	3
Fishhook Creek	1998	11	--	11
	1999	15	--	15
	2000	18	--	18
	2001	26	--	26
	2002	17	--	17
	2003	17	--	17
	2004	11	--	11
	2005	23	--	23
	2006	25	--	25
	2007	22	--	22
	2008	13	14	27
	2009	21	12	33
	2010	17	10	27
	2011	11	7	18
	2012	21	9	30
	2013	15	13	28
	2014	6	8	14
	2015	61	2	63
Fourth of July Creek	2003	16	--	16

Table 37. (continued)

Stream	Year	Older transect redds	Newer transect redds	Total redds
Fourth of July Creek	2004	33	--	33
	2005	41	--	41
	2006	71	--	71
	2007	49	--	49
	2008	26	--	26
	2009	50	--	50
	2010	56	--	56
	2011	51	--	51
	2012	54	--	54
	2013	21	--	21
	2014	85	--	85
	2015	51	--	51

Table 38. Bull trout redds counted in the Hayden Creek drainage in the Lemhi River basin, 2002 - 2015.

Stream	Year	Older transect redds	Newer transect redds	Total redds
Bear Valley Creek	2002	26	--	26
	2003	42	--	42
	2004	44	--	44
	2005	34	--	34
	2006	26	60	86
	2007	25	115	140
	2008	27	21	48
	2009	42	24	66
	2010	37	22	59
	2011	36	103	139
	2012	33	91	124
	2013	41	78	119
	2014	66	134	200
	2015	39	98	137
East Fork Hayden Creek	2002	33	--	33
	2003	25	--	25
	2004	26	--	26
	2005	41	--	41
	2006	49	--	49
	2007	52	--	52
	2008	61	--	61
	2009	54	--	54
	2010	55	--	55
	2011	32	--	32
	2012	49	--	49
	2013	34	--	34
	2014	23	--	23
	2015	40	--	40
Hayden Creek	2005	22	--	22
	2006	74	--	74
	2007	115	--	115
	2008	28	--	28
	2009	22	--	22
	2010	--	29	29
	2011	--	49	49
	2012	--	39	39
	2013	--	14	14

Table 38. (continued)

Stream	Year	Older transect redds	Newer transect redds	Total redds
Hayden Creek	2014	--	29	29
	2015	--	18	18

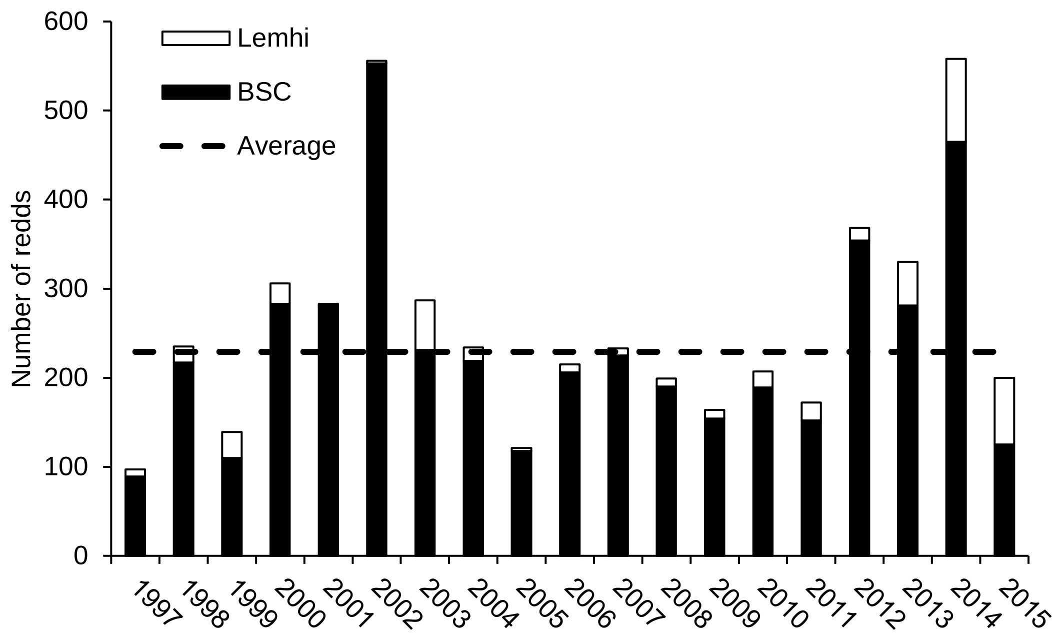

Figure 49. Resident Rainbow Trout redds counted during ground surveys in the upper Lemhi River (Beyeler Ranch) and Big Springs Creek (BSC) (Neibaur and Tyler ranches), 1997 - 2015.

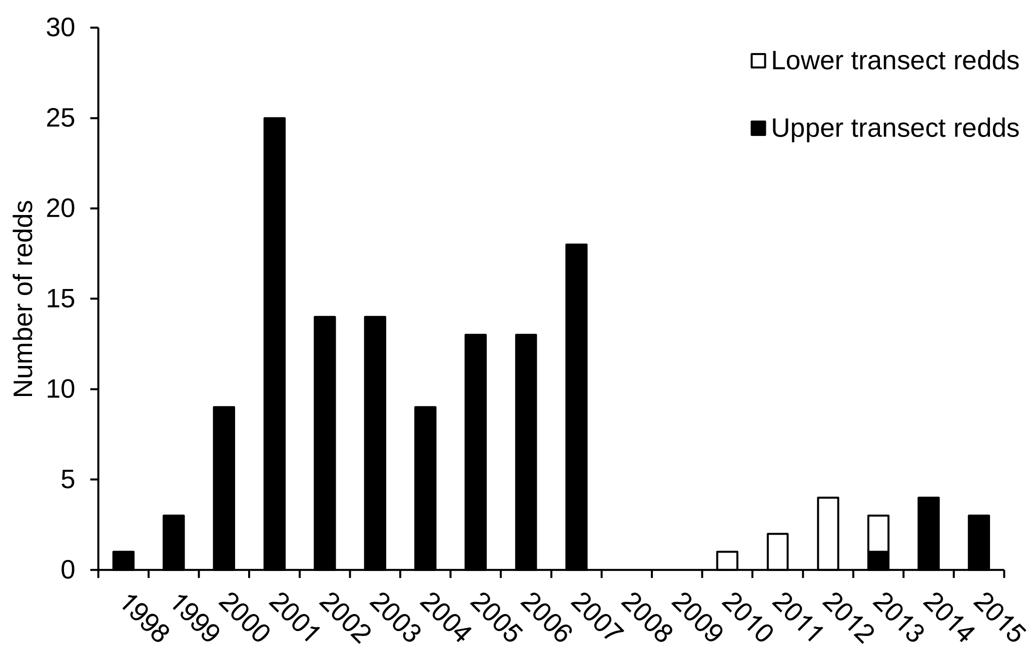

Figure 50. Number of Bull Trout redds counted in both survey transects on Alpine Creek, 1998 - 2015.

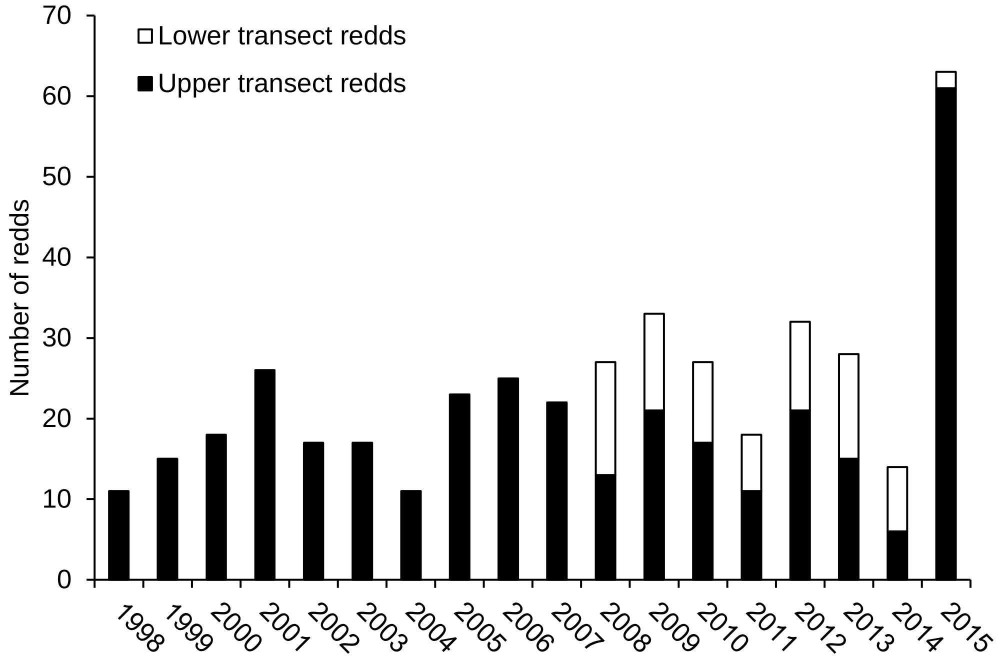

Figure 51. Number of Bull Trout redds counted in both transects on Fishhook Creek, 1998 - 2015.

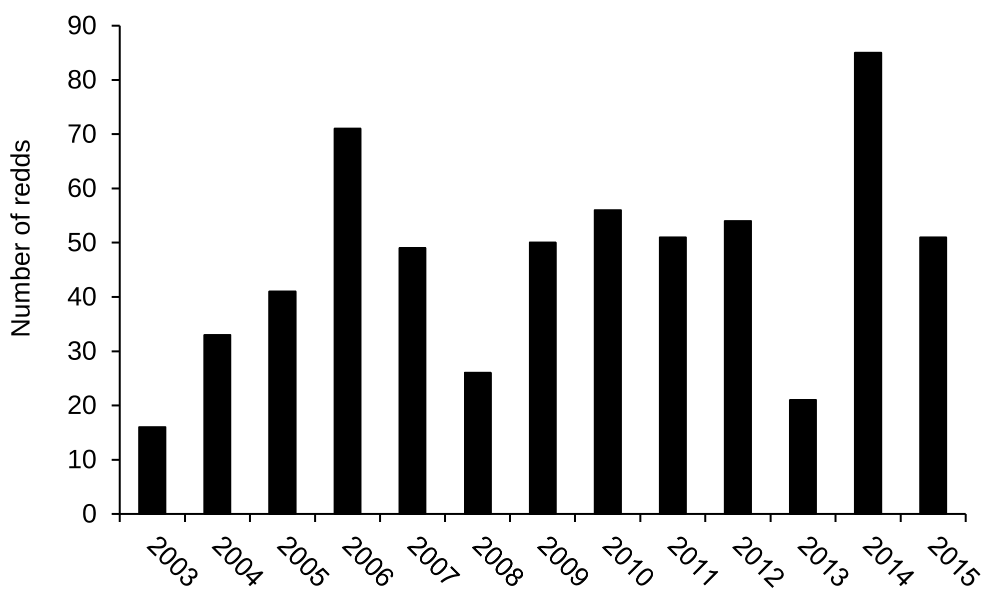

Figure 52. Number of Bull Trout redds counted on Fourth of July Creek, 2003 - 2015.

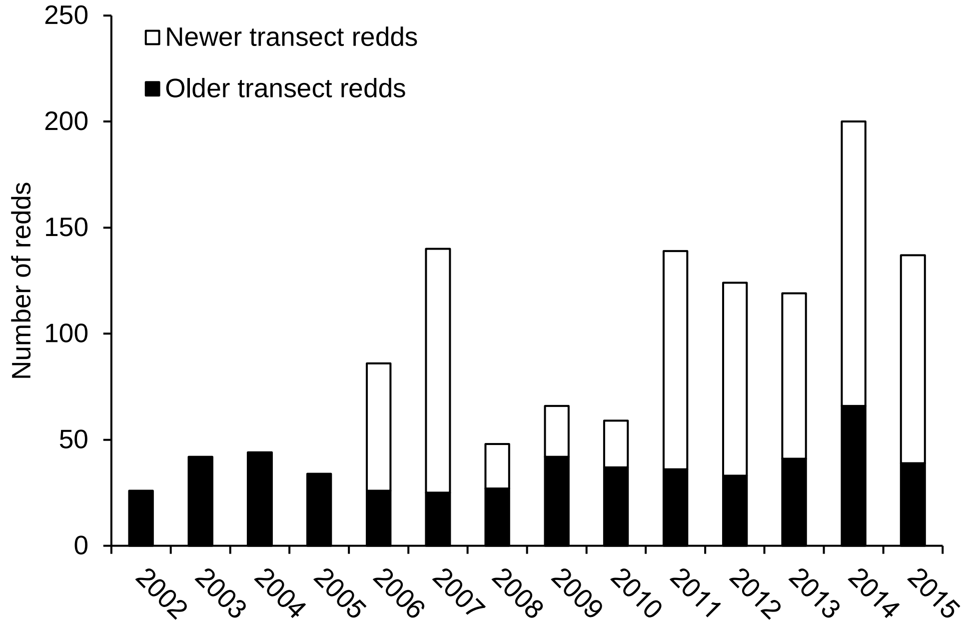

Figure 53. Number of Bull Trout redds observed in the Bear Valley Creek transects, 2002 - 2015.

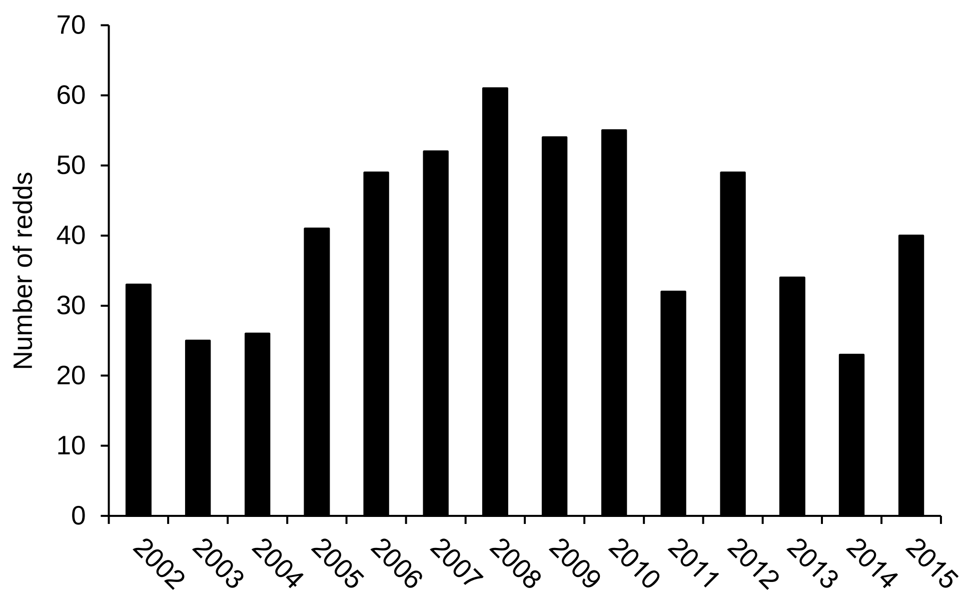

Figure 54. Number of Bull Trout redds observed in East Fork Hayden Creek trend transect, 2002 - 2015.

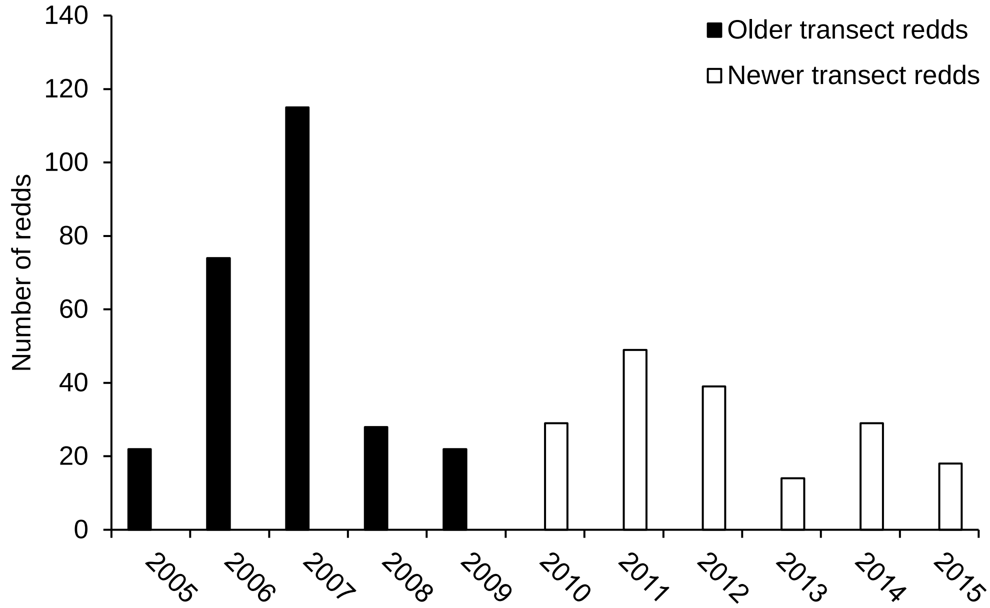

Figure 55. Number of Bull Trout redds observed in upper Hayden Creek redd count trend transect, 2005 - 2015.

RIVERS AND STREAMS:

MIDDLE FORK SALMON RIVER TREND MONITORING

ABSTRACT

During July 2015, IDFG personnel snorkeled 36 trend transects in the Middle Fork Salmon River (MFSR) drainage to determine fish species composition, size, abundance, and density. Thirty-one mainstem Middle Fork Salmon River (MFSR) transects and five tributary transects were snorkeled. For main stem transects surveyed in 2015 (n = 31), Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* had an overall mean density (± SE) of 0.43 fish/100 m^2 (± 0.10), Rainbow Trout /Steelhead *O. mykiss* mean density was 0.10 fish/100 m^2 (± 0.05), and juvenile Chinook Salmon *O. tshawytscha* mean density was 0.54 fish/100 m^2 (± 0.44). In tributary transects surveyed in 2015 (n = 5), Westslope Cutthroat Trout had an overall mean density of 3.27 fish/100 m^2 (± 1.50), Rainbow Trout /Steelhead mean density was 1.17 fish/100 m^2 (± 0.64), and juvenile Chinook Salmon mean density was 2.88 fish/100 m^2 (± 0.89).

In 2015, 25% (n = 20) of the 81 Westslope Cutthroat Trout observed during main stem snorkel surveys were greater than 300 mm TL, compared to 13% in 1971 (prior to catch-and-release regulations implemented in 1972). Thirty-six percent (n = 77) of Westslope Cutthroat Trout caught during angling surveys in 2015 were greater than 300 mm TL, compared to 20% in 1972. Average angler catch rate during surveys has remained relatively stable over the last seven years (2.8 to 5.8 fish/hr) and was 4.3 fish/hr in 2015. Westslope Cutthroat Trout accounted for 47% of the total angler catch and Rainbow Trout/Steelhead accounted for 39% in 2015.

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Matt Belnap, Regional Fisheries Biologist

INTRODUCTION

The earliest fishery study conducted on the Middle Fork Salmon River (MFSR) was a tagging study that took place in 1959 and 1960, and evaluated seasonal movement, age and growth structure, and mortality of Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*, to determine the impacts of a rapidly increasing recreational fishery (Mallet 1960, 1961). The study concluded that Cutthroat Trout in the MFSR could experience major declines due to year-round fishing pressure, and it was recommended at that time to decrease the daily bag limit on Cutthroat Trout. Eventually catch-and-release regulations were put in place in 1972, and IDFG began monitoring abundance and size structure of MFSR Westslope Cutthroat Trout to evaluate the effects of catch-and-release regulations.

A 1971 study established snorkeling transects to be surveyed periodically in the MFSR drainage for monitoring fish population trends (Corley 1972; Jeppson and Ball 1977, 1979). In the 1971 report, these transects are described as main stem historical (Corley) transects (*n* = 6). In 1981, additional main stem transects were established in order to monitor Steelhead *O. mykiss* populations on the MFSR (Thurow 1982, 1983, 1985). In 1985, the Department added additional snorkel sites to estimate Steelhead, juvenile Chinook Salmon *O. tshawytscha*, and Westslope Cutthroat Trout densities throughout the mainstem and its tributaries (Reingold and Davis 1987a, 1987b, 1988; Lukens and Davis 1989; Davis et al. 1992; Schrader and Lukens 1992; Liter and Lukens 1992). The snorkel sites established in 1981 are known in this report as traditional main stem (*n* = 28) or traditional tributary (*n* = 10) transects. The Salmon Region has been snorkeling trend sites since 1971 and has been periodically monitoring trends in fish species composition and size structure caught during angling surveys in the MFSR since 1959. In 2008 we began recording fishing effort (angling hours) to monitor angler catch rates during those surveys.

OBJECTIVES

1. Monitor Rainbow Trout/Steelhead, juvenile Chinook Salmon, and Westslope Cutthroat Trout densities within the MFSR and its tributaries to evaluate long-term trends in population status.

2. Collect otoliths from Westslope Cutthroat Trout in the MFSR main stem to evaluate current age structure, growth rates, and total annual survival.

3. Monitor angling catch rates, particularly for Westslope Cutthroat Trout, to evaluate long-term trends relating to angler satisfaction.

STUDY AREA AND METHODS

The Middle Fork Salmon River (MFSR) (Figure 56) is part of the Wild and Scenic Rivers System and flows through the Frank Church River of No Return Wilderness in central Idaho. The MFSR originates at the confluence of Bear Valley and Marsh creeks near Cape Horn Mountain. It flows 171 km to its confluence with the Salmon River, 92 km downstream from Salmon, Idaho. The MFSR is a major recreational river offering a wide variety of outdoor and back-country experiences. The number of people floating the river has increased substantially in the past 50 years, from 625 in 1962 to 10,601 in 2014. The U.S. Forest Service estimated total use days during the 2014 permit season on the MFSR (May 28-Sept. 3) to be 58,537 days (USFS website).

Mainstem and Tributary Snorkeling Transects

MFSR snorkeling transects were sampled using snorkeling techniques described by Thurow (1982). Snorkeling was conducted by two snorkelers floating downstream with the current, remaining as motionless as possible, along both sides of the river margin. The area surveyed was estimated by multiplying the length snorkeled by the visible corridor (i.e. visibility). Visibility was measured at each site by suspending a sighting object in the water column and allowing the snorkeler to drift downriver until the object was unidentifiable. The snorkeler then moved upriver until the object reappeared clearly. The measured distance (m) between the object and the observer's facemask was the visibility.

Historical transects on the mainstem MFSR were established prior to 1985 while traditional transects were established after 1985. Four of six MFSR historical (Corley) transects, 27 of 28 traditional main stem transects, and five of 10 traditional tributary transects were snorkeled during July 21 to 28, 2015. Physical information on snorkel sites surveyed in 2015 is located in Appendices C, D, and E.

Project Angling

The main objective of 'project angling' is to evaluate current trends in angler catch rates and sizes of fish in angler creels. Project anglers used conventional fly-fishing and spin cast gear to gather catch rate and creel size information on 152.5 km of the mainstem MFSR from Boundary Creek to the confluence with the Salmon River in 2015. Anglers documented the exact amount of time fished, gear type used, and size and species of their catch, to add to an existing trend dataset that has been sporadically maintained since 1959, and consistently maintained since 2003.

Westslope Cutthroat Trout Age, Growth, and Survival

In 2015, we also sacrificed three to five Westslope Cutthroat Trout from each 10 mm size class to collect otoliths, to calculate length-at-age and total annual survival, and compare with results from Mallet in 1959-1960, prior to catch-and-release regulations (Mallet 1960, 1961).

Otoliths were cleaned of debris and mucus, and stored in dry vials. Otoliths were then mounted in epoxy and cross-sectioned using an isometric saw (Beamish 1979, Casselman 1983). Sections were mounted on microscope slides and digital images were taken under 40x magnification. Digital images were read by two independent technicians and, if independent readers were not in agreement on an age, a third reader was used to assign a consensus age to the otolith.

Using the program Fishery Analyses and Modeling Simulator (FAMS) (Slipke and Maceina 2014), we constructed an age-length key in order to determine the proportion of fish of each age, in each length group. Mean length-at-age was then calculated from the age-length keys according the methods outlined in Chapter 16 (Determination of Age and Growth) in Murphy and Willis (1996). To compare length at age in this study to data collected in 1959-1960 by Mallet (1961, 1963), we multiplied his fork length data by 1.055 to convert to total length (Mallet 1961; Carlander 1969).

To estimate total annual survival, we used a standard catch curve and performed the calculations in FAMS (Slipke and Maceina 2014).

RESULTS AND DISCUSSION

Mainstem and Tributary Snorkeling Transects

Average densities (± SE) for Westslope Cutthroat Trout, Rainbow Trout, and Chinook Salmon parr in traditional mainstem MFSR transects were 0.42 fish/100 m^2 (± 0.11), 0.11 fish/100 m^2 (± 0.06), and 0.62 fish/100 m^2 (± 0.50), respectively (Table 39). Average Mountain Whitefish density was 0.34 fish/100 m^2 (± 0.13) in traditional main stem transects (Table 39). No Bull Trout *Salvelinus confluentus* or Brook Trout *S. fontinalis* were observed in traditional main stem transects in 2015. Average fish densities at the five historical main stem (Corley) sites snorkeled in 2015 were 0.50 fish/100 m^2 (± 0.29) for Cutthroat Trout, 0.04 fish/100 m^2 (± 0.04) for Rainbow Trout/Steelhead, and 0.03 fish/100 m^2 (± 0.03) for Mountain Whitefish in 2015 (Table 39). No Bull Trout, Brook Trout, or Chinook Salmon parr were observed at the Corley sites in 2015. The trend in average densities for Cutthroat, Rainbow/Steelhead, Chinook Salmon parr, and Mountain Whitefish across all main stem sites over the last seven years have tracked very similarly (Figure 57). The apparent link in population trends for all four species over several years suggests any increases or decreases in population abundance are likely influenced by environmental or other unknown factors that affect a large geographical area (Copeland and Meyer 2011).

In the five traditional tributary transects we snorkeled in 2015, fish densities averaged 3.27 fish/100 m^2 (±1.5) for Westslope Cutthroat Trout, 1.17 fish/100 m^2 (± 0.64) for Rainbow Trout/Steelhead, 1.1 fish/100 m^2 (± 0.6) for Chinook Salmon parr, 1.2 fish/100 m^2 (± 0.6) for Bull Trout, and 3.13 fish/100 m^2 (± 1.48) for Mountain Whitefish (Table 39). No Brook Trout were observed in traditional tributary transects in 2015.

Catch-and-release regulations on the main stem MFSR have been in effect since 1972. Prior to catch-and-release regulations, in 1971, the percent of Cutthroat greater than 300 mm TL observed during snorkel surveys was 13%. That figure has ranged from 13% to 60% since that time. In 2015, 25% (n = 25) of the 81 Cutthroat observed were greater than 300 mm TL in main stem MFSR transects (Figure 58).

Snorkeling transects in the mainstem MFSR were established in 1971 and 1981 (Corley 1972; Thurow 1982) and likely represent one of the longest term trend data sets on Westslope Cutthroat Trout throughout their range. However, little has been done to evaluate what transects provide accurate trends in mimicking population abundance (High et al. 2008). Also, some transects are difficult and dangerous to snorkel during flow conditions over a river stage of 2.5 ft on the Middle Fork Lodge gauge. Survey counts conducted during high flows may represent inherent snorkeler bias since a snorkeler may not be able to accurately observe fish when challenged by difficult waters.

Project Angling

IDFG anglers caught 455 fish from the mainstem MFSR during 2015 angling surveys (Table 40). Westslope Cutthroat Trout accounted for 47% of our total catch (n = 214) while Rainbow Trout/Steelhead accounted for 39% (n = 179) (Table 41). Mountain Whitefish, Northern Pikeminnow *Ptychochelius oregonensis*, suckers (various spp), Redside Shiners

Richardsonius balteatus, Bull Trout, and trout hybrids accounted for the remaining 14% (Table 41). The proportion of each species caught during angling surveys was very similar in 2013, 2014, and 2015 for Westslope Cutthroat Trout and Rainbow Trout/Steelhead, but the proportion of other species (i.e. Bull Trout, Brook Trout, Northern Pikeminnow, Mountain Whitefish, suckers [various spp.], Redside Shiners, and hybrids) caught doubled compared to 2014 and tripled compared to 2013 (Figure 59). We are unsure why this was the case. For Bull Trout x Brook Trout hybrids (Table 41), this may have just been a result of our increased ability to determine whether these fish are in fact hybrids, because of better information keys to differentiate hybrids them. Angler catch per unit effort (CPUE) has fluctuated between 2.8 fish/hour and 5.8 fish/hour since 2009 when we began recording angling effort times (mean 3.9 fish/hr). In 2015, CPUE was 4.3 fish/hour (Table 40; Figure 60).

Prior to catch-and-release regulations going into effect in 1972, approximately 20% of the Westslope Cutthroat Trout caught by project anglers were over 300 mm TL. Since the regulation change, the proportion has fluctuated annually, ranging from 26% to 53% (mean 38.5%) (Figure 61). In 2015, the proportion of Westslope Cutthroat Trout larger than 300 mm TL caught by project anglers was 36% (n = 77). Recent annual fluctuation of this value could be attributed to a difference in angler skill level, gear type, sample timing, river discharge, and water clarity. However, this value has remained relatively stable since 2010 (Figure 61).

We were effectively able to capture Westslope Cutthroat Trout larger than 160 mm TL with angling gear in 2015 (Figure 62). Anglers collected otoliths from a representative subsample of 94 Westslope Cutthroat Trout in 2015 for age and growth and annual survival estimation (Table 42). Length-at-age analysis revealed that Westslope Cutthroat Trout reached approximately 220 mm TL by age 2, approximately 309 mm TL by age 5, and approximately 355 mm TL by age 7 (Table 43, Figure 63). Although length-at-age 2 is higher than Mallet observed in 1960 (Mallet 1963), mean length at older ages is lower (Table 43). This is likely a result of reduced total annual mortality, higher abundance, and slower growth for Westslope Cutthroat Trout currently associated of catch-and-release regulations. Total annual survival in 2015 was estimated at 60%, versus 32% in 1959-1960 (Mallet 1963).

Although Westslope Cutthroat Trout growth is slower in 2015 than in 1959-1960, the substantial decrease in annual mortality coincides with excellent catch rates. Additionally, approximately one third (36%) of the catch measured greater than 300 mm, compared to only 20% before catch-and-release regulations were imposed. This has produced arguably the highest quality trout fishery in the Salmon Region at present time.

MANAGEMENT RECOMMENDATIONS

1. Continue annual monitoring of Westslope Cutthroat Trout, Rainbow Trout/Steelhead, and juvenile Chinook Salmon in all 28 main stem sites, 10 tributary sites, and 6 historical mainstem MFSR sites by snorkeling between the second week of July and the third week of August.

2. Continue monitoring angling catch rates (fish/hour) every year on the Middle Fork Salmon River to assess trends to provide up-to-date information for anglers, guides, and outfitters.

Table 39. Densities of salmonids observed during snorkel surveys in the MFSR drainage in 2015.

Site	Trout Fry	Rainbow Trout/ Steelhead	Chinook Salmon Parr	Cutthroat Trout	Bull Trout	Brook Trout	Whitefish
Historical main stem sites (Corley)							
Mahoney	0.00	0.00	0.00	1.33	0.00	0.00	0.00
White Creek PB	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Bernard Airstrip	0.00	0.18	0.00	0.36	0.00	0.00	0.00
Hancock Pool	0.00	0.00	0.00	0.23	0.00	0.00	0.12
Mean	0.00	0.04	0.00	0.50	0.00	0.00	0.03
SE	0.00	0.04	0.00	0.29	0.00	0.00	0.03
Minimum	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Maximum	0.00	0.18	0.00	1.33	0.00	0.00	0.12
Traditional main stem sites							
Boundary	0.00	0.71	0.00	0.24	0.00	0.00	1.67
Gardell's	0.00	0.43	0.00	0.71	0.00	0.00	1.70
Velvet	0.00	0.00	13.51	0.97	0.00	0.00	0.00
Elkhorn	0.00	0.00	0.37	1.84	0.00	0.00	2.94
Sheepeater	0.38	1.51	1.70	0.57	0.00	0.00	0.57
Greyhound	0.00	0.00	0.00	0.44	0.00	0.00	0.22
Rapid R	0.00	0.28	0.00	1.41	0.00	0.00	0.00
Indian	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pungo	0.00	0.00	0.00	0.00	0.00	0.00	0.50
Marble Pool	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ski Jump	0.37	0.00	0.12	0.00	0.00	0.00	0.25
Lower Jackass	0.00	0.00	0.00	0.53	0.00	0.00	0.00
Cougar	0.00	0.00	1.00	0.00	0.00	0.00	0.33
Whitey Cox	0.00	0.00	0.00	0.18	0.00	0.00	0.00
Rock Island	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Hospital Pool	0.00	0.00	0.00	0.45	0.00	0.00	0.00
Hospital Run	0.00	0.00	0.00	0.54	0.00	0.00	0.27
Tappan Pool	0.00	0.00	0.00	0.50	0.00	0.00	0.17
Flying B	0.00	0.00	0.00	2.12	0.00	0.00	0.00
Airstrip	0.00	0.00	0.00	0.21	0.00	0.00	0.00
Survey	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Big Cr PB	0.00	0.00	0.00	0.09	0.00	0.00	0.09
Love Bar	0.00	0.00	0.00	0.17	0.00	0.00	0.17
Little Ouzel	0.00	0.00	0.00	0.16	0.00	0.00	0.00
Otter Bar	0.00	0.00	0.00	0.29	0.00	0.00	0.00
Goat Pool	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goat Run	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 39. (continued)

Site	Trout Fry	Rainbow Trout/ Steelhead	Chinook Salmon Parr	Cutthroat Trout	Bull Trout	Brook Trout	Whitefish
Mean	0.03	0.11	0.62	0.42	0.00	0.00	0.34
SE	0.02	0.06	0.50	0.11	0.00	0.00	0.13
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.38	1.51	13.51	2.12	0.00	0.00	2.94
Traditional tributary sites							
Camas L1	0.00	0.48	2.62	3.10	0.00	0.00	8.33
Loon L1-Bridge	0.00	0.00	2.40	8.93	0.00	0.00	3.09
Marble Lower	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pistol L1	0.00	2.23	5.21	2.23	0.00	0.00	3.72
Pistol L2	0.00	3.13	4.17	2.08	0.00	0.00	0.52
Mean	0.00	0.83	2.06	2.33	0.00	0.00	2.24
SE	0.00	0.49	0.81	1.20	0.00	0.00	1.18
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	3.13	5.21	8.93	0.00	0.00	8.33

Table 40. Summary of fish caught during angling surveys on the mainstem MFSR, 1959 to 2015.

Year	WCT	RBT/ STHD	BLT	MWF	WCTxRBT	BUTxEBT	CHN	EBT	NPM	SUC	RSS	Total # of fish	Total hours of effort	CPUE
1959	143	112	11	0	0	0	0	0	0	0	0	266	UNK	n/a
1960	484	103	94	0	0	0	0	0	0	0	0	681	UNK	n/a
1969[a]	166	0	0	0	0	0	0	0	0	0	0	166	UNK	n/a
1975	158	109	11	4	0	0	0	0	0	0	0	282	57.5	4.9
1976	75	14	2	2	0	0	0	0	0	0	0	93	UNK	n/a
1978	160	91	0	13	0	0	0	0	0	0	0	264	86.0	3.1
1979	139	112	0	0	0	0	0	0	0	0	0	251	UNK	n/a
1990	735	339	2	0	0	0	0	0	0	0	0	1076	UNK	n/a
1991	42	54	0	0	3	0	0	0	0	0	0	99	UNK	n/a
1992	42	53	0	1	0	0	0	0	0	2	0	98	UNK	n/a
1993	242	66	0	0	6	0	0	0	0	0	0	314	UNK	n/a
1999	182	132	0	0	8	0	0	0	0	0	0	322	UNK	n/a
2003	167	91	0	0	0	0	1	0	0	0	1	260	UNK	n/a
2004	243	184	1	0	0	0	1	0	1	0	0	430	UNK	n/a
2005	226	157	7	2	4	0	0	0	5	0	0	401	UNK	n/a
2007	264	253	2	6	1	0	0	0	16	0	0	542	UNK	n/a
2008	64	90	0	0	1	0	0	0	0	0	0	155	26.9	5.8
2009	340	230	2	4	8	0	0	1	14	0	2	601	166.0	3.6
2010	174	115	8	21	3	0	2	2	0	0	0	325	116.2	2.8
2011	109	47	0	6	0	0	0	0	0	0	0	162	42.0	3.9
2012	299	206	11	14	4	0	0	0	5	1	1	541	145.9	3.7
2013	200	195	1	6	1	1	3	0	9	0	0	416	102.0	4.1
2014	167	137	3	7	1	1	0	0	6	3	2	327	98.7	3.3
2015	214	179	3	12	10	0	29	0	8	0	0	455	104.9	4.3

[a] Only WCT enumerated

WCT=Westslope Cutthroat Trout, RBT/STHD=Rainbow Trout/Steelhead, BUT=Bull Trout, MWF=Mountain Whitefish, CHN=Chinook Salmon, EBT=Eastern Brook Trout, NPM=Northern Pikeminnow, SUC = Sucker spp., RSS=Redside Shiner.

CPUE = fish/hr

Table 41. Percentage of each salmonid species represented in total catch during angling surveys on the mainstem MFSR, 1959 to 2015. 1969 was omitted due to only enumerating WCT that year.

Year	WCT	RBT/STHD	BUT	EBT	MWF	CTxRBT	BUTxEBT
1959	54%	42%	4%	0%	0%	0%	0%
1960	71%	15%	14%	0%	0%	0%	0%
1975	56%	39%	4%	1%	0%	0%	0%
1976	81%	15%	2%	2%	0%	0%	0%
1978	61%	34%	0%	5%	0%	0%	0%
1979	55%	45%	0%	0%	0%	0%	0%
1990	68%	32%	0%	0%	0%	0%	0%
1991	42%	55%	0%	0%	3%	0%	0%
1992	43%	54%	0%	1%	0%	0%	0%
1993	77%	21%	0%	0%	2%	0%	0%
1999	57%	41%	0%	0%	2%	0%	0%
2003	64%	35%	0%	0%	0%	0%	0%
2004	57%	43%	0%	0%	0%	0%	0%
2005	56%	39%	2%	0%	1%	0%	0%
2007	49%	47%	0%	1%	0%	0%	0%
2008	41%	58%	0%	0%	1%	0%	0%
2009	57%	38%	0%	1%	1%	0%	0%
2010	54%	35%	2%	6%	1%	0%	1%
2011	67%	29%	0%	4%	0%	0%	0%
2012	55%	38%	2%	3%	1%	0%	0%
2013	48%	47%	0%	1%	0%	0%	1%
2014	51%	42%	1%	2%	0%	0%	0%
2015	47%	39%	1%	3%	2%	0%	6%
mean	57%	38%	1%	1%	1%	0%	0%

WCT=Westslope Cutthroat Trout, RBT/STHD=Rainbow Trout/Steelhead, BUT=Bull Trout, MWF=Mountain Whitefish, CHN=Chinook Salmon, EBT=Eastern Brook Trout.

Table 42. Summary of otoliths collected from Westslope Cutthroat Trout (WCT) in the mainstem MFSR, 2015.

Species	Length group (mm TL)	# otoliths taken
WCT	170-179	1
WCT	180-189	3
WCT	190-199	3
WCT	200-209	5
WCT	210-219	4
WCT	220-229	4
WCT	230-239	4
WCT	240-249	3
WCT	250-259	5
WCT	260-269	8
WCT	270-279	2
WCT	280-289	5
WCT	290-299	7
WCT	300-309	3
WCT	310-319	4
WCT	320-329	6
WCT	330-339	3
WCT	340-349	6
WCT	350-359	5
WCT	360-369	3
WCT	370-379	3
WCT	380-389	2
WCT	390-399	4
WCT	400-409	0
WCT	410-419	0
WCT	420-429	0
Total	Total	94

Table 43. Comparisons of length at age (mm) for Westslope Cutthroat Trout in the Middle Fork Salmon River, 1959-1960 and 2015.

	1963 (Mallet)	2015	
Age	Mean TL	Mean TL	95% CI
2	206	220	33.3
3	258	218	6.9
4	308	281	12.3
5	368	309	17.6
6	406	324	8.7
7	--	355	8.8

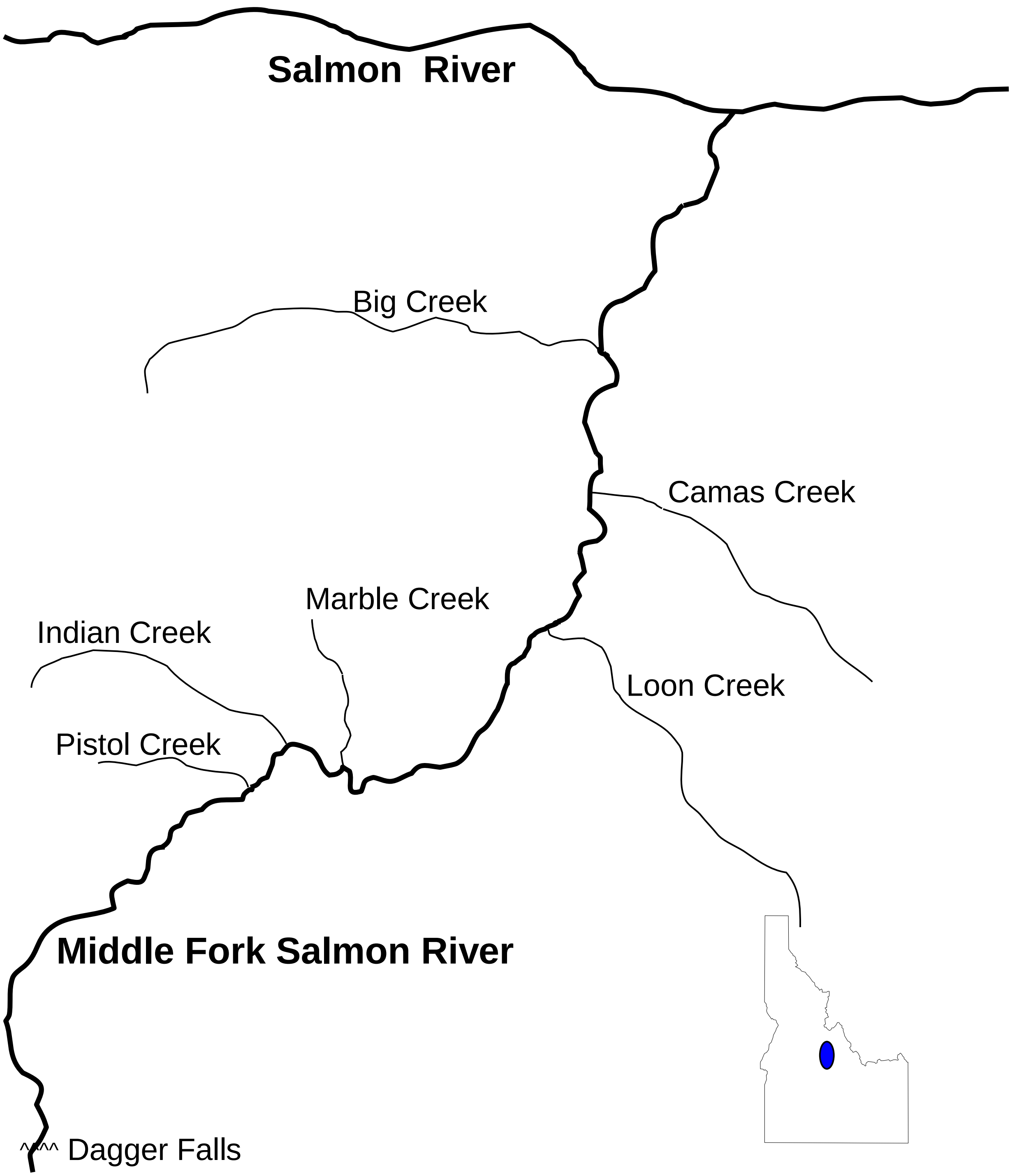

Figure 56. Map of the Middle Fork Salmon River and its major tributaries, Idaho.

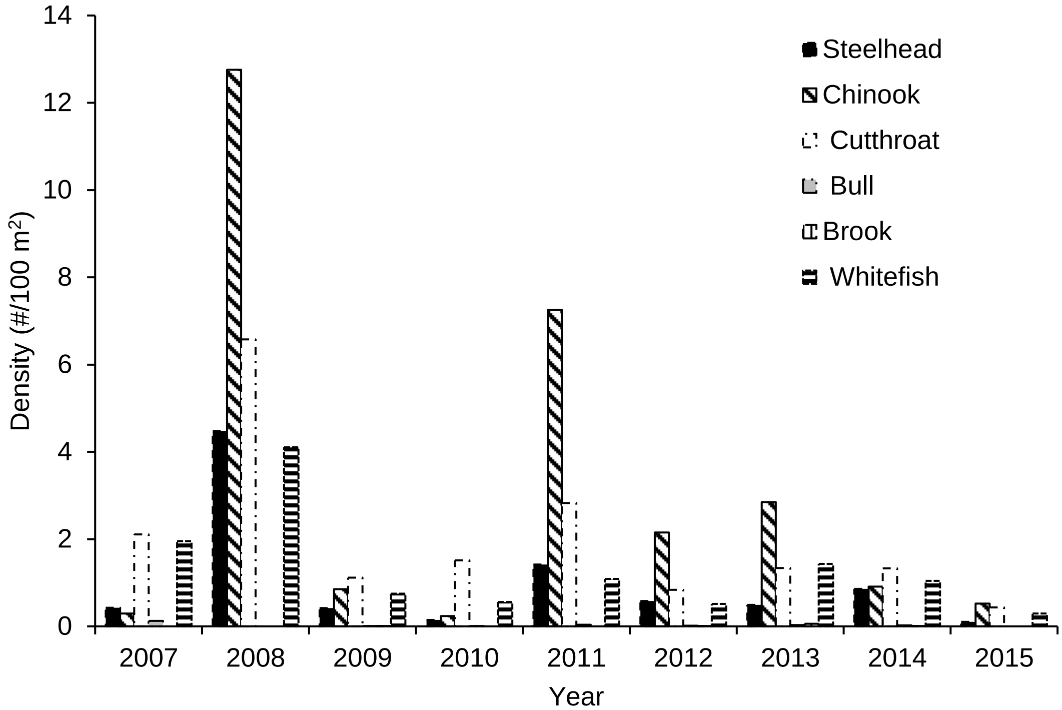

Figure 57. Average densities of salmonids observed in mainstem MFSR snorkel transects, 2007 to 2015.

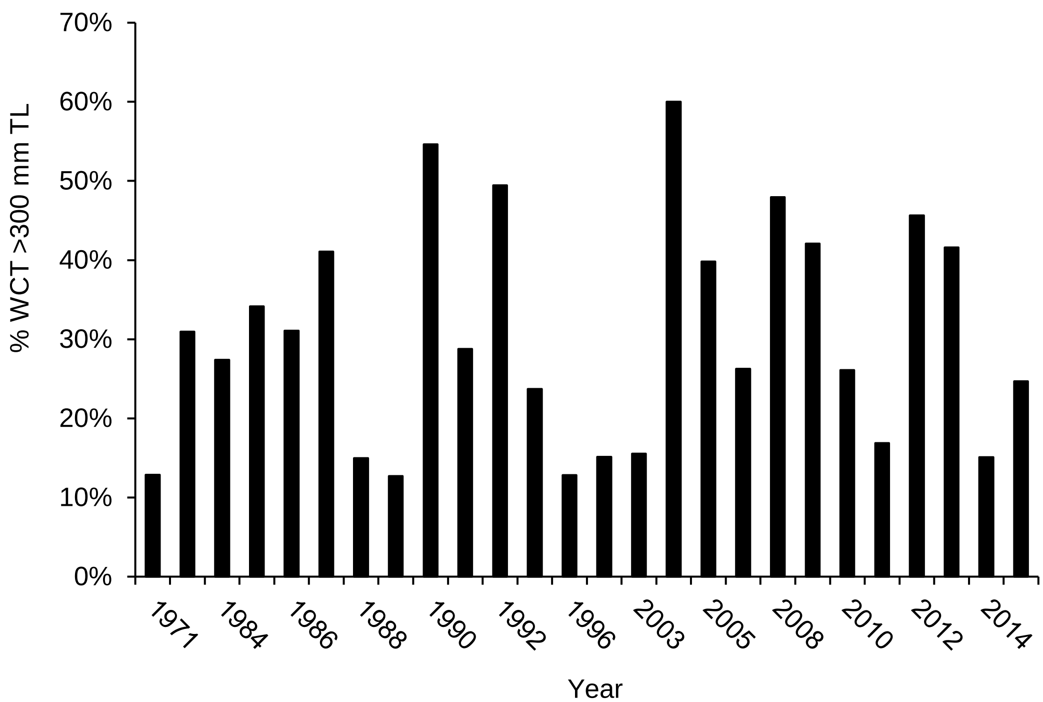

Figure 58. Percentage of Westslope Cutthroat Trout greater than 300 mm TL observed during snorkel surveys in the mainstem MFSR, 1971 to 2015.

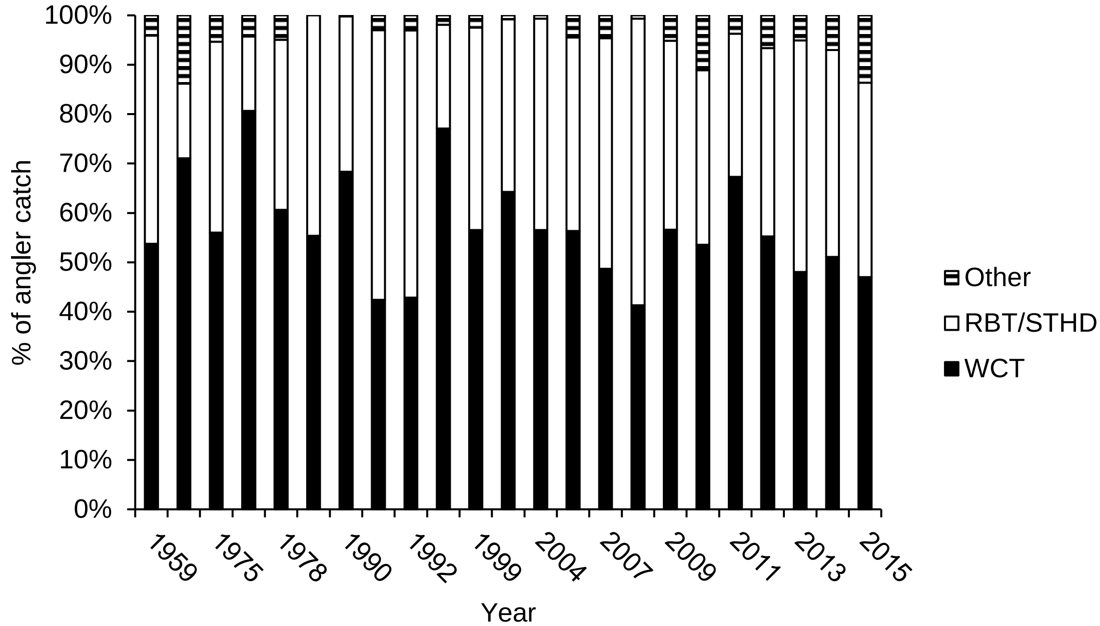

Figure 59. Percentage of Rainbow Trout/Steelhead (RBT/STHD), Westslope Cutthroat Trout (WCT), and other species (Other) represented in total angler catch during angling surveys on the mainstem MFSR, 1959 to 2015.

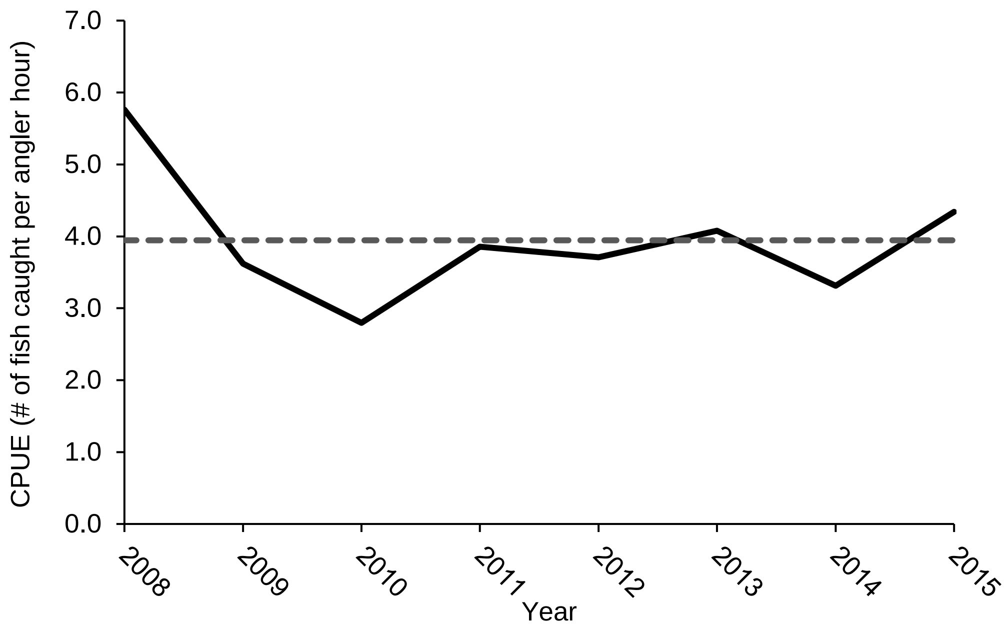

Figure 60. Catch per unit effort (CPUE) (# of fish caught per angler hour) estimated from hook and line sampling on the Middle Fork of the Salmon River between 2008 and 2015. The gray dotted line represents the mean (3.9 fish per angler hour) CPUE estimated over this time period.

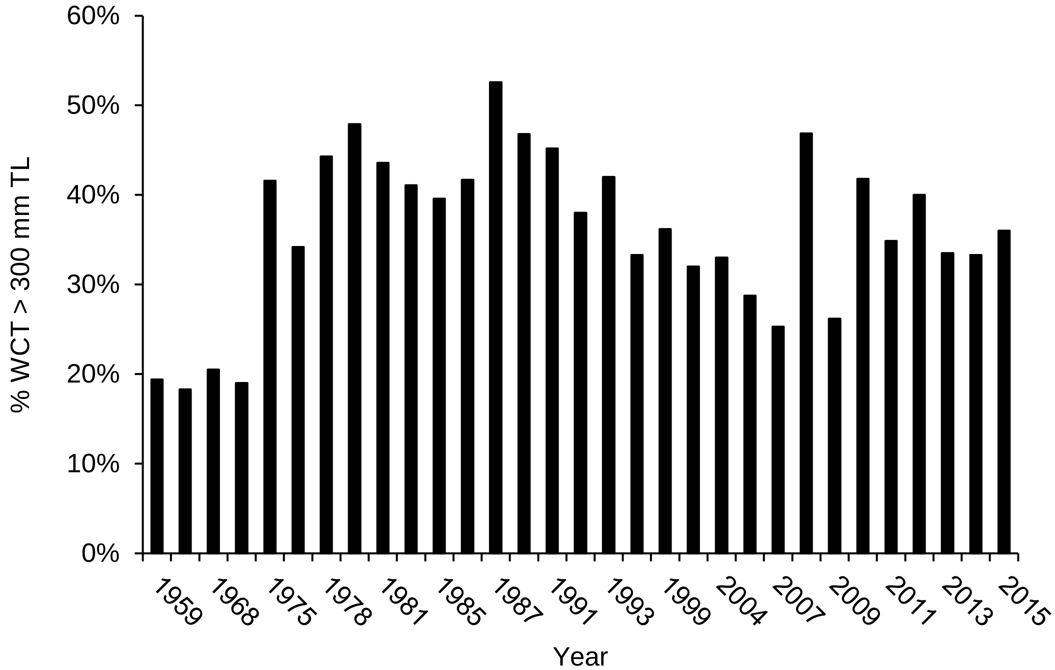

Figure 61. Percentage of Westslope Cutthroat Trout greater than 300 mm TL caught during angling surveys on the Middle Fork Salmon River, 1959 to 2015.

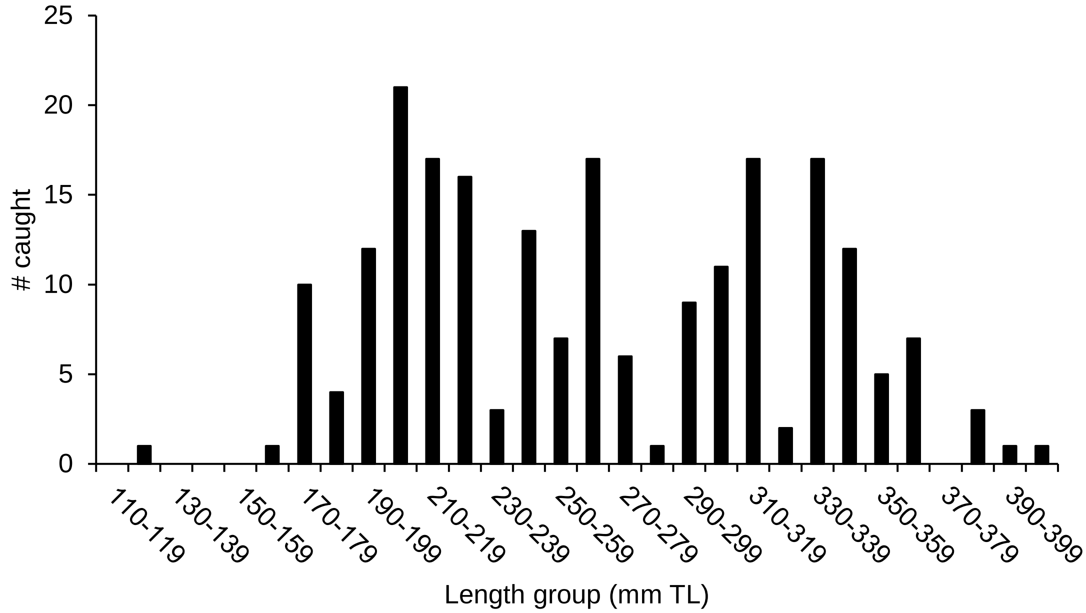

Figure 62. Frequency of Westslope Cutthroat Trout caught in each total length category during angling surveys in 2015 on the Middle Fork Salmon River.

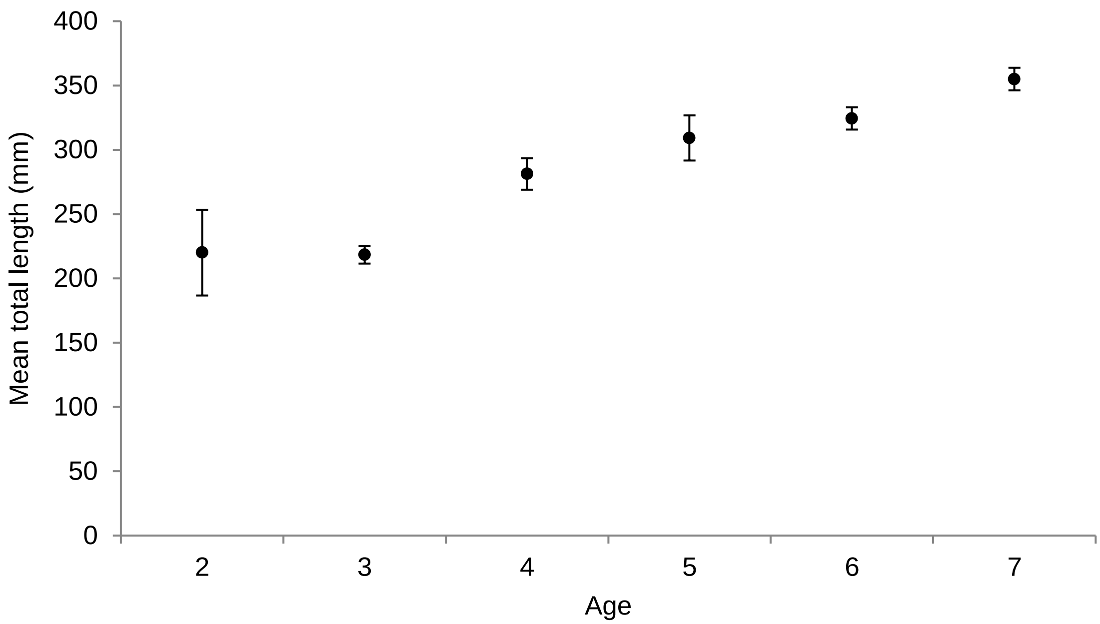

Figure 63. Length at age (with 95% confidence intervals) of Westslope Cutthroat Trout from the Middle Fork Salmon River in 2015.

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Appendix A. Intercept (a) and slope (b) parameters for standard weight (W_s) equations, taken from Blackwell et al. (2000). $Log_{10}(W_s) = a' + b * Log_{10}(\text{total length (mm)})$

Species	Intercept (*a*)	Slope (*b*)	Minimum TL (mm)	Source
Brown Trout (lentic)	-4.867	2.96	140	Milewski and Brown, 1994
Cutthroat Trout (lotic)	-5.192	3.086	130	Kruse and Hubert, 1997
Cutthroat Trout (lentic)	-5.189	3.099	130	Kruse and Hubert, 1997
Lake Trout	-5.681	3.246	280	Piccolo et al., 1993
Mountain Whitefish	-5.086	3.036	140	Rogers et al., 1996
Tiger Muskellunge	-6.126	3.337	240	Rogers and Koupal, 1997
Northern Pikeminnow	-4.886	2.986	250	Parker et al., 1995
Rainbow Trout (lentic)	-4.898	2.99	120	Simpkins and Hubert, 1996
Rainbow Trout (lotic)	-5.023	3.024	120	Simpkins and Hubert, 1996
Smallmouth Bass	-5.329	3.2	150	Kolander et al., 1993
White Sturgeon	-5.795	3.232	700	Beamesderfer, 1993

Appendix B. Wild trout redd count trend transect coordinates and lengths.

		Start		End		
Species/ Transect	Year established	Latitude (°N)	Longitude (°W)	Latitude (°N)	Longitude (°W)	Length (km)
Rainbow Trout						
Big Springs Creek - Tyler	1994	44.70896	113.39917	44.72855	113.43430	3.4
Big Springs Creek - Neibaur	1994	44.70047	113.38436	44.70896	113.39917	4.5
Upper Lemhi River	1994	44.68689	113.36273	44.69945	113.37074	3.0
Bull Trout						
Alpine Creek - upper	1998	43.90705	114.93078	43.90357	114.94457	1.5
Alpine Creek - lower	2010	43.89707	114.91327	43.90245	114.92246	1.5
Fishhook Creek - upper	1998	44.13706	114.96703	44.13472	114.97622	1.0
Fishhook Creek -lower	2008	44.14882	114.93716	44.13992	114.96205	3.5
Fourth of July Creek	2003	44.04112	114.75831	44.05039	114.69165	5.0
Hayden Creek	2010	44.70624	113.73430	44.37053	113.75771	2.5
Bear Valley Creek - upper	2007	44.78332	113.75496	44.79685	113.80820	4.7
Bear Valley Creek - lower	2002	44.77624	113.74259	44.78332	113.75496	1.7
East Fork Hayden Creek	2002	44.72984	113.67145	44.72438	113.66671	1.5

Appendix C. Locations and dimensions of mainstem traditional transects, Middle Fork Salmon River, surveyed in 2015.

Transect name	River km[a]	Transect length (m)	Visibility (m)	Transect area (m^2)	Traditional species[b]
Boundary	0.9	61	2.3	910.8	SB
Gardells Hole	4.6	126	2.9	621.6	C2, CK
Velvet	8.8	37	2.5	1424.8	C2, CK
Elkhorn	14.1	68	2.2	800.8	SB
Sheepeater	21.3	102	2.1	1647.2	SB
Greyhound	25.8	99	2.3	1798.0	C2, CK
Rapid River	29.6	74	2.1	932.4	SB
Indian	40.8	137	2.6	360.0	SB
Pungo	45.1	77	2.6	460.0	C2, CK
Marble Pool	51.7	142	2.9	775.2	C2, CK
Skijump	52.3	155	2.9	927.2	SB
Lower Jackass	60.9	111	2.1	2400.0	C2, CK
Cougar	65.9	50	1.8	576.0	SB
Whitie Cox	74.9	102	1.9	448.8	C2, CK
Rock Island	75.2	122	1.9	931.6	SB
Hospital Pool	82.9	80	1.8	720.0	C2, CK
Hospital Run	84.3	66	1.7	748.0	SB
Tappan Pool	94.9	137	1.7	600.0	C2, CK
Flying B	106.6	75	2.4	600.0	C2, CK
Airstrip	108.6	110	1.7	1332.0	SB
Survey	119.0	75	2.0	600.0	SB
Big Creek Bridge	124.6	185	1.8	2880.0	C2, CK
Love Bar	127.0	100	1.5	626.4	SB
Little Ouzel	143.2	87	1.8	915.2	SB
Otter Bar	144.0	143	1.6	768.0	C2, CK
Goat Creek Pool	151.5	134	1.6	857.6	C2, CK
Goat Creek Run	151.8	122	2.2	1073.6	SB

[a] River km readings start at Dagger Falls.

[b] Traditional steelhead transects established in 1981: SB = Steelhead B-run. Traditional Cutthroat Trout (C2) and Chinook Salmon (CK) transects established in 1985:

Appendix D. Locations and dimensions of mainstem Middle Fork Salmon River historical (Corley 1972) transects surveyed in 2015.

Transect name	River location[a] (km)	Transect length (m)	Visibility (m)	Transect area (m^2)	Traditional species[a]
Mahoney Camp	67.4	50	2.3	561.2	SB,C2, CK
White Creek Pack Bridge	78.1	300	2.0	1461.6	SB,C2, CK
Bernard Airstrip	109.4	100	1.5	370.0	SB,C2
Hancock Rapids Hole	147.0	120	1.6	856.8	C2

[a] River km reading begins at Dagger Falls.
[b] SB = Steelhead B-run, C2 = Westslope Cutthroat Trout, and CK = Chinook Salmon.

Appendix E. Locations and dimensions of Middle Fork Salmon River tributary transects surveyed in 2015.

Transect name	Transect location	Transect length (m)	Visibility (m)	Transect area (m^2)	Traditional species[a]
Pistol Creek Lower	125 m above pack bridge	28.0	1.2	720.0	SB,C2, CK
Pistol Creek Upper	100 m above lower site	40.0	2.3	699.2	SB,C2, CK
Marble Creek	Above pack bridge	64.0	1.8	460.8	SB,C2, CK
Loon Creek Lower	Below pack bridge	52.0	2.8	313.6	SB,C2, CK
Camas Creek Lower	Below pack bridge	75.0	2.8	448.0	SB,C2

[a] SB = Steelhead B-run, C2 = Westslope Cutthroat Trout, and CK = Chinook Salmon.

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